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SPHACELOMA ON WILLOW IN NEW ZEALAND

By ANNA E. JENKINS, *U.S. Department of Agriculture, Washington, D.C., U.S.A., and* LEON GRODSINSKY, *Ministerio de Agricultura de la Nacion, Buenos Aires, Argentina*

(With 1 Text-figure)

A special study of several destructive fungous-diseases of crack willow (*Salix fragilis* L.) and weeping willow (*S. babylonica* L.) growing in the Nelson district of New Zealand was made by Murray (1926). One of these maladies was reported to be the 'commonest disease of the crack-willows in this district' and also to affect weeping willows, although less frequently. The pathogen was referred to *Gloeosporium Capreae* Allesch., a species previously described on goat willow (*Salix Caprea* L.) from Germany. Murray pointed out, however, that her diagnosis of the fungus from New Zealand was not fully in agreement with the description of *Gloeosporium Capreae*. The present account is concerned with a new taxonomic interpretation of the fungus causing the willow disease discovered by Murray in New Zealand, here termed 'Gray Scab of Willow'.

Her description of this fungus follows:

> The fungus occurs only upon the leaves, forming upon the upper surface small round or irregular somewhat raised spots, greyish-white with a narrow dark-brown margin, varying from 0·5 mm. to 2 mm. in diameter, very often confluent and forming large irregular patches often up to 1·5 cm. long and exceptionally to 3·5 cm.; sometimes, especially when large and near the margin or tip of the leaf, a large part of the diseased area may drop away from the leaf; there is a tendency for the blotches to follow the veins of the leaf, so that long narrow patches may frequently be found along the midrib and larger veins (Plate II, fig. 3).* The spots are covered with minute black dots where the acervuli break through the cuticle. The under-surface of the leaf becomes discoloured with dark-brown areas corresponding to the spots above, but the acervuli are borne principally upon the upper surface.
>
> The acervuli are crowded, brown, small, 80–120 mm. in diameter, often confluent, in which case they are larger, erumpent, lifting up and breaking through the cuticle; conidiophores light-brown, 15–20 × 1–2 mm., bearing small oblong to oval, hyaline, one-celled conidia, 5–12 × 3–6 mm., often 2-guttulate (text-fig. 4).*

Miss Murray's illustrations represent an infected leaf of crack willow, showing many lesions, and a line drawing of an acervulus, the latter here reproduced (Fig. 1).

The fungus thus described by Murray is a typical species of *Sphaceloma* de Bary emend. Jenkins & Bitancourt (1941). Her account of this minute pathogenic organism appears to constitute the first record of any species of this genus on willow. The light brown conidiophores and the spore characters which she pointed out to be unlike those of Allescher's *Gloeosporium* on goat willow are characteristic of species of *Sphaceloma*. Murray's fungus appears to be distinct from the species described by Allescher.

* Not reproduced here.

Unfortunately, no material of this rarely reported European fungus is at hand. In Nannfeldt's (1931) tabulation of species of *Gloeosporium* on *Salix*, *Gloeosporium Capreae*, which, however, is accorded no special discussion, is among the few species retained in that genus. The omission of *G. subcuticulare* Caballero (1929) from the tabulation is doubtless owing to the nearly synchronous publication of the two articles concerned. In some respects the diagnosis of Caballero's species, described on crack willow from Spain, agrees more closely with the *Sphaceloma* from New Zealand than does *Gloeosporium Capreae*. There is no similarity between the two species, however, as was proved by a microscopic examination of authentic material of *G. subcuticulare*, contributed by Caballero. Judging from Miss Murray's description, the *Sphaceloma* on willow bears a certain resemblance to *S. Populi* (Sacc.) Jenkins (1933, 694), which is pathogenic on *Populus*, the other genus of the willow family. Nevertheless, before formulating any statement concerning the closer relationships of these two fungi, they should be critically compared, a problem beyond the scope of this paper.

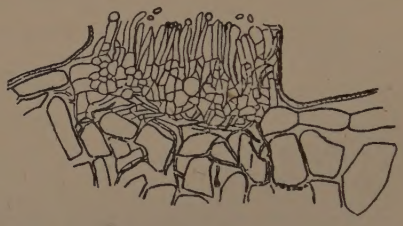

Fig. 1. *Sphaceloma Murrayae* on crack willow from New Zealand. After Murray. ×330.

As no fungus seems to have been described on *Salix* co-specific with the *Sphaceloma* discovered on *Salix* in New Zealand by Murray, it seems advisable to treat her fungus as a new species. It therefore is named in her honour, and a diagnosis in Latin based on her description in English follows:

Sphaceloma Murrayae sp.n. (Fig. 1)

Maculae epiphyllae parvae vel irregulares, paulo elevatae, griseo-albae margine angusto nigro-brunneo, hypophyllae nigro-brunneae, 0·5–2 mm. in diam., saepe confluentes et areas irregulares usque 1·5 cm., rare 3·5 cm. longas formantes, interdum praecipue magnae et prope marginem vel apicem folii locatae desciscentes, frequenter nervisequentes longae et angustae; acervuli abundantes, nigro-punctiformes, conferti, brunnei, parvi, 80–120μ in diam., saepe confluentes majoresque, cuticulam levantes et rumpentes; conidiophora pallide brunnea, 15–20μ longa, 1–2μ lata; conidia parva, oblonga vel ovoidea, hyalina, unicellularia, 5–12μ longa, 3–6μ lata, saepe 2-guttulata.

Hab. in foliis *Salicis fragilis* et rarius *S. babylonicae* (Salicaceae), prope Nelson, Nov. Zeland.

Icones: Murray, J. B., Pl. II, fig. 3 et Text-fig. 4. *Trans. Proc. N.Z. Inst.* LVI, 64–65, 1926, as *Gloeosporium Capreae* Allesch.

Sphaceloma Murrayae has also been found on *Salix viminalis* L., Delta del Paraná and Latvia, and on *S. fragilis*, United States. Grodsinsky, L. and Jenkins, A. E. *In* Rev. Argentine de Agron. (Unpublished.)

The work reported in this paper was done mainly in 1940, when the junior author was on leave of absence in the United States.

REFERENCES

Caballero, A. (1929). Algunas novedades botánicas de la Real Casa de Campo y de El Pardo. *Mem. Soc. esp. Hist. nat.* xv, 309–14.

Jenkins, A. E. (1933). *Elsinoe* on apple and pear. *J. agric. Res.* xliv, 689–700.

Jenkins, A. E. & Bitancourt, A. A. (1941). Revised descriptions of the genera *Elsinoe* and *Sphaceloma*. *Mycologia*, xxiii, 338–40.

Murray, B. J. (1926). Three fungus diseases of *Salix* in New Zealand and some saprophytic fungi on the same hosts. *Trans. Proc. N.Z. Inst.* lvi, 58–70.

Nannfeldt, J. A. (1931). Contributions to the mycoflora of Sweden. 2. *Excipula sphaeroides* Fr., some other discomycetes on *Salix*-leaves and their conidial stages. *Svensk bot. Tidskr.* xxv, 1–31.

(*Accepted for publication* 15 *April* 1942)

ON THE GENERIC NAMES *PSEUDOMONAS*, *XANTHOMONAS* AND *BACTERIUM* FOR CERTAIN BACTERIAL PLANT PATHOGENS

By W. J. DOWSON, *Botany School, Cambridge*

It has long been recognized that the majority of bacterial plant pathogens are very similar to certain commonly occurring saprophytic species with which they may have evolved from a common ancestral type. Thus the green fluorescent plant pathogens may be regarded as parasitic forms of the saprophytes *Pseudomonas fluorescens* Migula and *P. putida* Migula, the former of which possesses proteolytic enzymes absent in the latter, i.e. one liquefying gelatine, the other unable to do so. Soft-rotting plant pathogens are closely akin to the colon bacillus both in morphological characters and in biochemical activities. All these bacteria were classified by Lehmann and Neumann (1927) in their genus *Bacterium*, which comprised all the Gram-negative non-sporing, rod-shaped forms irrespective of the presence or absence of flagella. They divided the genus into subgenera according to the arrangement of flagella when present, such as *Bacterium* proper, containing bacteria with peritrichous flagella, and *Pseudomonas*, with polar flagella. The latter name was taken from Migula's system (1900) and embraced the same organisms as Migula had in mind, namely, green fluorescent forms possessing a tuft of polar flagella and yellow species provided with a single polar flagellum. Many bacteriologists consider this to be the natural position for the plant pathogens as it indicates that they are regarded as but distinct species of the two genera *Bacterium* and *Pseudomonas*.

In Bergey's system (1939) the same two groups are recognized, but under different names and in different positions in the classification. The pathogens with peritrichous flagella are not placed in the same genus as the colon bacillus (called by Bergey *Escherichia*) but in a separate genus, *Erwinia* Winslow *et al.*, though both are included with other genera in a family Enterobacteriaceae. The other group of plant pathogens, corresponding to *Pseudomonas* Migula, is placed in a genus *Phytomonas* Bergey, which is grouped next to *Pseudomonas* (also borrowed from Migula) in the family Pseudomonadaceae. These two genera, *Erwinia* and *Phytomonas*, were created solely for bacteria pathogenic to plants, irrespective of all other characters.

I recently (1939, 1941) discussed the characters of a number of plant pathogens, compared them with the colon bacillus and with *Pseudomonas fluorescens*, and gave reasons for rejecting the generic names *Erwinia* and *Phytomonas*. The generic name *Bacterium* was retained but was redefined. *Pseudomonas* Migula was split into two genera. *Pseudomonas* Migula em. Dowson was used for the green fluorescent bacteria with a tuft of polar flagella, e.g. *P. syringae*, and *Xanthomonas* Dowson for the yellow forms with a single polar flagellum such as *Pseudomonas campestris*. A definition of the

proposed new genus *Xanthomonas* was provided and *Bacterium hyacinthi* Wakker (1884) was selected as type species. This proposal is in accordance with the International Rules of Botanical Nomenclature and has received approval both in Britain and in America. Some authorities, however, while accepting *Xanthomonas* and *Pseudomonas* (Migula) emend. still prefer *Erwinia* to *Bacterium* for the peritrichous plant pathogens, i.e. *Erwinia carotovora* rather than *Bacterium carotovorum*. The genus *Erwinia* should be discarded for the following reasons. It was created on one character alone, that of pathogenicity to plants (Winslow, C.-E. A., Broadhurst, J., Buchanan, R. E., Krumweide, C., Rogers, L. A. & Smith, G. H., 1917). Bergey evidently regarded this as valid, for he stated: 'Tribe II Erwineae Winslow *et al.* (1920). Plant pathogens. Invade the tissues of plants and produce local lesions; some killing the host plants. Usually motile with peritrichous flagella. Ferment dextrose and lactose with formation of acid, or acid and visible gas. Usually attack pectin. There is a single genus *Erwinia* (Winslow *et al.*).'

The few biochemical activities recorded in this definition are equally applicable to other bacteria, including the colon bacillus of the genus *Escherichia*, which Bergey defined as: '*Escherichia* Castellani and Chalmers. Non-spore forming, Gram-negative short rods fermenting dextrose and lactose with acid and gas. Commonly occurring in the intestinal canal of animals. Widely distributed in nature. M.R. test positive. Voges-Proskauer reaction negative. Carbon dioxide and hydrogen produced in approximately equal volumes from dextrose.' The only real difference between the two definitions is that of habitat, plants in one, animals in the other. *Erwinia carotovora* (Jones) Holland, *E. aroideae* (Townsend) Holland, *E. phytophthora* (Appel) Bergey and *E. tracheiphila* (Erw. Smith) Holland, however, are found in the intestinal canal of certain insects (Johnson, 1930; Gilbert, 1928) as well as in plants, and according to Bergey the first two are widely distributed in nature.

The separation of plant pathogens from the similar colon-typhoid group was not accepted even in America without protest, for Breed, Conn & Baker (1918) wrote: 'still more questionable is the genus *Erwinia*. . . . It is very doubtful, indeed, whether peritrichic plant parasites are sufficiently distinct from saprophytes to be put in a genus by themselves.' Moreover, Burkholder (1930) stated that: 'this tribe (i.e. Erwineae) is based entirely upon the ability of its members to cause disease in plants, and all other characters of the bacteria are disregarded. The reason for the separation of the plant pathogens was not discussed and it seems evident that the close relationship of the genus *Erwinia* to the *coli* group, and certain members of the genus *Phytomonas* to the fluorescent group was overlooked or not known.' Commenting on the fifth edition of Bergey, Burkholder (1939) observed: 'it is no longer considered that the plant pathogens form a distinct group of their own, and the concept that plant pathogenicity is a generic character is being weakened.' In Europe bacteriologists also took exception to the separation. Topley and Wilson (1936) stated: 'we have retained the genus *Erwinia*. . . . It seems doubtful whether the plant pathogens should be segregated in this way. . . .'

In addition to separating the components of the colon-typhoid group on habitat and pathogenicity small differences in biochemical activity were also regarded as generic characters by the compilers of Bergey's system. For instance, Bergey's tribe V of the Enterobacteriaceae is called Salmonellae and contains two 'genera', *Salmonella* Lignières and *Eberthella* Buchanan, which are distinguished by the fact that the latter fails to form gas in fermenting a number of carbohydrates. Other biochemical activities, such as the reduction of nitrates to nitrites, which all the members of the Enterobacteriaceae are said to do (Bergey *et al.* 1939, p. 388), do not appear to matter, for *Erwinia* includes four species that do not exhibit this character. Two of them are the plant pathogens *E. amylovora* and *E. tracheiphila*. In fact, apart from such small differences the four 'genera' *Escherichia*, *Erwinia*, *Eberthella* and *Salmonella* are identical.

The characters upon which Bergey relied to distinguish genera were therefore differences in habitat, or in pathogenicity, or in chemical activity, which many bacteriologists regard as useful only in differentiating species. These biochemical differences are not always sufficient even to distinguish species, for, as Lacey (1939) has shown, different isolates of the fasciation and leafy gall bacterium (*Corynebacterium fascians* (Tilford) Dowson) may or may not produce acid from lactose. Kluyver and van Niel (1936) used the generic name *Bacterium* for most of the colon-like bacteria, and in referring to their definition of the genus they stated (p. 402 footnote 2): 'it should be well understood that in this genus are included the genera *Proteus*, *Salmonella*, *Eberthella* and *Shigella* which nowadays are frequently used. Although specialists dealing with this group may feel the need for further subdivision, yet it is unacceptable to us to differentiate genera on such trifling characters as are used in the current systems. Two organisms which ferment glucose in essentially the same way should not, in our opinion, be placed in separate genera, because one of them ferments (i.e. hydrolyses) also lactose. Nor should this be done because one of them splits formic acid into carbon dioxide and hydrogen, whereas the other does not (i.e. acid but no gas produced!).' Topley and Wilson (1936) also adopted the generic name *Bacterium* with certain reservations and amendments for those bacteria comprising what is generally recognized as the colon-typhoid-dysentery group, apart from which it is 'in accordance with the reports of the American Committee' (Winslow *et al.* 1917 and 1920). For convenience they divided the genus into five groups: Coli-aerogenes, Friedländer, paracolon, dysentery and *Salmonella*, but they pointed out the tendency of specialists concentrating on any one group to subdivide it according to some definite character such as antigenic structure, and to consider that particular group as a genus regardless of closely similar groups. Topley and Wilson also drew attention to the different methods adopted by specialists for denoting the 'species' into which a group is divided and compared *Salmonella* with *Streptococcus* (*Pneumococcus*). The former has been divided into numerous 'species' according to differences in antigenic structure and place of isolation, e.g. *Salmonella newport* var. *Kottbus* or *S. enteritidis* var. *Chaco*, whereas the latter has been separated into numbered antigenic types, e.g. *Streptococcus pneumoniae* Type VIII.

Topley and Wilson concluded (1936, p. 549): 'while in full agreement with the Salmonella sub-committee in regard to the fundamental importance of antigenic structure and the necessity for labelling each new type it appears to us that the accordance of specific rank to each of the ultimate types that can be differentiated by these means is a questionable procedure. It will clearly increase the present chaos of bacteriological nomenclature if we attach one meaning to the term "species" in the genus *Bacterium* and another meaning in the genus *Streptococcus*...we feel unable to adopt the generic name *Salmonella* which the sub-committee upholds.'

The same differences in biochemical activities and in antigenic structure are thus held by one school of bacteriologists to be *specific* and by another to be *generic*, and are instances of the fundamentally different and sometimes incompatible aims in classifying organisms. The aim of one school is to group related forms in such a way as to express the probable course of evolution, which means that attention is chiefly paid to similarities between forms. The aim of another school is to differentiate species and to arrange all organisms in artificial keys by reference to which any unknown species may be readily identified. They pay more attention to differences than to similarities. Bergey's *Manual* is a catalogue of species and a work of reference with artificial keys for identification in which differences are more accentuated than similarities. Kluyver and van Niel's system, on the other hand, is an attempt to classify bacteria according to their supposed lines of morphological and physiological evolution, and it involves the use of katabolic products as aids or indications in differentiating species. The 'genera' of Bergey's family Enterobacteriaceae become the 'species' of the genus *Bacterium* as defined by Topley and Wilson and by Kluyver and van Niel.

The terms genera and species as applied to bacteria are hard to define. To quote Topley and Wilson (1936, p. 217) they 'seem to us to defy definition, except as designations for two convenient groupings of which the genus is the larger including group, and the species the smaller included group. For this reason and because of the absence of any form of international agreement, we doubt the usefulness, at the present time, of naming orders, families, subfamilies and tribes. Nor do we feel that the time is ripe for the creation of a large number of genera, or for the erection of an inelastic system into which all known varieties of bacteria are to be forced, each with its appropriate label.' In classifying the colon-like bacteria it seems to me that this is the best principle to follow, and in adopting *Bacterium* as a generic name for this group of bacteria more accurate information can be conveyed in a binomial than by dividing the group into so-called genera, the names of which convey no sense of relation between the various subgroups. The names *Bacterium salicis*, *Bact. coli*, *Bact. typhosum*, and *Bact. enteritidis* undoubtedly provide more information about these four organisms than do the names *Erwinia salicis*, *Escherichia coli*, *Eberthella typhi* and *Salmonella enteritidis*. The specific epithets tell us that the organisms are connected with willows, the large intestine, typhoid fever and enteric fever respectively, but whereas in the first series the use of the

single generic name implies that all four bacteria are closely related, in the second series no such relation is indicated and the generic names merely commemorate four distinguished bacteriologists. For these reasons I consider that the generic names *Erwinia*, *Escherichia*, *Eberthella* and *Salmonella* should be rejected and replaced by *Bacterium*.

The chief objection to the generic name *Bacterium* is stated by Breed and Conn (1936) to be that 'the type species *Bacterium triloculare* Ehrenberg 1828 (monotypy) is unrecognizable. Because this species is unrecognizable subsequent authors have felt free to redefine the genus. As none of these new definitions have won universal approval, it is necessary to state how the term is being used each time it is used or confusion results. This situation pointedly illustrates the need for the rule that generic terms not associated with a recognizable type are invalid....' But there is nothing in the International Rules of Botanical Nomenclature to prevent the redefining of a generic name, and this has in fact been done more than once, e.g. with *Bacillus*. Furthermore, Breed and Conn (1936) omit all mention of the very significant fact that 'subsequent authors who felt free to redefine the genus' chose the same organism for their type species, viz. the colon bacillus, the original name of which was *Bacterium coli commune* (Escherich, 1885). The generic name *Bacterium* as used by these subsequent authors has in fact a very recognizable type species, and the one combination to receive more approval than any other for this well-known bacterium is *Bact. coli*. Moreover, under the type species concept 'the genus is defined primarily by means of a type species rather than by means of a statement of the common distinguishing characters of the species in the genus' (Breed, 1928).

The generic name *Bacterium* is used at the present time for the whole of the colon-typhoid-dysentery group by medical bacteriologists such as Topley and Wilson (1936), and for a part of the group by Jordan and Burrows (1941) who excluded the typhoid-paratyphoid bacteria for which they recognized the generic name *Salmonella*. Kluyver and van Niel (1936) advocated *Bacterium* for the whole group except *Bact. aerogenes* which they placed under Beijerinck's genus *Aerobacter*. In plant pathology Brooks (1928) and Burgwitz (1936) adopted the definition of Lehmann and Neumann (1927) and used *Bacterium* for all bacterial plant pathogens, while Stapp (1937) employed this term for one peritrichous species only, and substituted *Bacterium* for *Bacillus* for the potato blackleg pathogen. Most authorities appear to agree that the scope of *Bacterium* as defined by Lehmann and Neumann is too comprehensive, and the consensus of opinion of the medical authorities who use this generic name seems to be that *Bacterium* should denote either the whole or at least a part of the colon-typhoid group. To this plant pathologists would add the peritrichous plant pathogens.

In conclusion, I would make the following recommendations based on the arguments brought forward above:

1. That the generic names *Erwinia*, *Escherichia*, *Eberthella*, *Salmonella* and others of Bergey's Enterobacteriaceae such as *Shigella*, *Klebsiella*, and *Aerobacter* be discarded.

2. That *Bacterium* Ehrenberg, 1828 be designated as a *nomen conservandum*.

3. That the type species of *Bacterium* should be designated as *Bacterium coli* Escherich, 1885.

4. That the genus *Bacterium* should be so defined as to include not only those species universally regarded as constituting the colon-typhoid-dysentery group but also the peritrichous plant pathogens.*

In conclusion I would like to express my thanks for helpful criticism and comments from Mr W. C. Moore and Dr S. P. Wiltshire, and particularly to Mr E. W. Mason for his advice regarding the authorities for the names in the list of pathogens.

The following is a list of the Gram-negative bacterial plant pathogens to be included in the three genera *Pseudomonas* Migula em. Dowson 1939, *Xanthomonas* Dowson, 1939 and *Bacterium* Ehrenberg em. Dowson 1939. Following most of the names are two synonyms, the first being the original name given to the organism together with its author and date, the second is that accepted by Bergey (1939). Where only one synonym appears it is the name advocated by Bergey.

Pseudomonas Migula emend. Dowson, 1939

P. aleuritidis (McCulloch & Demaree) Stapp; *Bacterium aleuritidis* McCulloch & Demaree, 1932; *Phytomonas aleuritidis* (McCulloch & Demaree) Magrou.

P. andropogonis (Smith) Stapp; *Bacterium andropogonis* E. F. Smith, 1911; *Phytomonas andropogonis* (Smith) Bergey.

P. angulata (Frome & Murray) Stapp; *Bacterium angulatum* Frome & Murray, 1919; *Phytomonas angulata* (Frome & Murray) Bergey.

P. apii Jagger, 1921; *P. jaggeri* Stapp; *Phytomonas jaggeri* (Stapp) Magrou.

P. aptata (Brown & Jamieson) Stapp; *Bacterium aptatum* Brown & Jamieson, 1913; *Phytomonas aptata* (Brown & Jamieson) Bergey.

P. atrofasciens (McCulloch) Stapp; *Bacterium atrofasciens* McCulloch, 1920; *Phytomonas atrofasciens* (McCulloch) Bergey.

P. barkeri (Berridge) Clara; *Bacillus barkeri* Berridge, 1924; *Phytomonas barkeri* (Berridge) Bergey.

P. berberidis (Thornberry & Anderson) Stapp; *Phytomonas berberidis* Thornberry & Anderson, 1935.

P. betae (Wieringa) n.comb.; *Phytomonas betae* Wieringa, 1927; *Phytomonas* wieringae (Elliott) Bergey.

P. bowlesii (Lewis & Watson) n.comb.; *Phytomonas bowlesii* Lewis & Watson, 1927.

P. calendulae (Takimoto) n.comb.; *Bacterium calendulae* Takimoto, 1936; *Phytomonas calendulae* (Takimoto) Bergey.

P. cannae (Bryan) Stapp; *Bacterium cannae* Bryan, 1921; *Phytomonas cannae* (Bryan) Bergey.

* With regard to recommendation 4, bacteriologists have accepted the principle of delimiting genera by International action (St John-Brooks & Breed, 1937), but no such provision is made in the International Rules of Botanical Nomenclature.

P. cerasi Griffin, 1911; *Phytomonas cerasi* (Griffin) Bergey (=*Bacterium trifoliorum* Jones *et al.*=*Bacterium holci* Kendrick. (See Clara, F. M. (1934), *Mem. Cornell Univ. Agric. Exp. Sta.* (159.))

P. coronafasciens (Elliott) Stapp; *Bacterium coronafasciens* Elliott, 1920; *Phytomonas coronafasciens* (Elliott) Bergey.

P. cumini (Kovacevski) n.comb.; *Phytomonas cumini* Kovacevski, 1936.

P. delphinii (Smith) Stapp; *Bacillus delphinii* E. F. Smith, 1904; *Phytomonas delphinii* (Smith) Bergey.

P. eriobotryae (Takimoto) n.comb.; *Bacterium eriobotryae* Takimoto, 1931; *Phytomonas eriobotryae* (Takimoto) Bergey.

P. erodii Lewis, 1914; *Phytomonas erodii* (Lewis) Bergey.

P. gardeniae (Burkholder) n.comb.; *Phytomonas gardeniae* Burkholder, 1941.

P. gladioli Severini, 1913; *Phytomonas gladioli* (Severini) Magrou.

P. glycinea Coerper, 1919; *Phytomonas glycinea* (Coerper) Burkholder (=*Pseudomonas sojae* (Wolf) Stapp).

P. hibisci (Nataka & Takimoto) Stapp; *Bacterium hibisci* Nataka & Takimoto, 1923; *Phytomonas hibisci* (Nataka & Takimoto) Bergey.

P. lacrymans (Smith & Bryan) Ferraris; *Bacterium lacrymans* Smith & Bryan, 1915; *Phytomonas lacrymans* (Smith & Bryan) Bergey.

P. maculicola (McCulloch) Stevens; *Bacterium maculicola* McCulloch, 1911; *Phytomonas maculicola* (McCulloch) Bergey.

P. marginalis (Brown) Stapp; *Bacterium marginale* Brown, 1918; *Phytomonas marginalis* (Brown) Bergey.

P. martyniae (Elliott) Stapp; *Bacterium martyniae* Elliott, 1924; *Phytomonas martyniae* (Elliott) Bergey.

P. matthiolae (Briosi & Paverino) n.comb.; *Bacterium matthiolae* Briosi & Paverino, 1912; *Phytomonas matthiolae* (Briosi & Paverino) Bergey.

P. medicaginis Sackett, 1910; *Phytomonas medicaginis* (Sackett) Bergey.

P. medicaginis var. *phaseolicola* (Burkholder) Dowson; *Phytomonas medicaginis* var. *phaseolicola* Burkholder, 1926. (I suggest *P. phaseolicola* n.comb. for this *Bacterium*.)

P. mellea (Johnson) Stapp; *Bacterium melleum* Johnson, 1923; *Phytomonas mellea* (Johnson) Bergey.

P. mori (Boyer & Lambert) Stevens; *Bacterium mori* Boyer & Lambert, 1893; *Phytomonas mori* (Boyer & Lambert) Bergey.

P. mors-prunorum Wormald, 1931; *Phytomonas mors-prunorum* (Wormald) Wormald.

P. nectarophila (Doidge) Dowson; *Bacterium nectarophilum* Doidge, 1917; *Phytomonas nectarophila* (Doidge) Bergey.

P. panacis (Takimoto) n.comb.; *Bacterium panaxi* Takimoto, 1922; *Phytomonas panaxi* (Takimoto) Magrou.

P. panici (Elliott) Stapp; *Bacterium panici* Elliott, 1923; *Phytomonas panici* (Elliott) Bergey.

P. papulans Rose, 1917; *Phytomonas papulans* (Rose) Bergey.

P. pisi Sackett, 1916; *Phytomonas pisi* (Sackett) Bergey.

P. primulae (Ark & Gardner) n.comb.; *Phytomonas primulae* Ark & Gardner, 1936.

P. prunicola Wormald, 1930; *Phytomonas prunicola* Wormald, 1930 (?=*P. cerasi*).

P. pseudozoogloeae (Honing) Stapp; *Bacterium pseudozoogloeae* Honing, 1914; *Phytomonas pseudozoogloeae* (Honing) Bergey.
P. punctulans (Bryan) n.comb.; *Bacterium tomato* Okabe, 1933; *Phytomonas tomato* (Okabe) Magrou. (See Bryan, 1933.)
P. rimaefasciens Koning, 1938; *Phytomonas rimaefasciens* (Koning) Bergey.
P. saliciperda Lindeijer, 1932; *Phytomonas saliciperda* (Lindeijer) Bergey.
P. savastanoi (Smith) Stevens; *Bacterium savastanoi* Smith, 1908; *Phytomonas savastanoi* (Smith) Bergey.
P. savastanoi var. *fraxini* (Brown) Dowson; *Bacterium savastanoi* var. *fraxini* Brown, 1932; *Phytomonas savastanoi* var. *fraxini* (Brown) Magrou. (I suggest *Pseudomonas fraxini* n.comb. for this organism.)
P. striafascians (Elliott) Stapp; *Bacterium striafascians* Elliott, 1927; *Phytomonas striafascians* (Elliott) Bergey.
P. syringae van Hall, 1902; *Phytomonas syringae* (Van Hall) Bergey. (=*Bacterium citriputeale* C. O. Smith=*Bacterium vignae* Gardner & Kendrick. See Clara, F. M. (1934), *Mem. Cornell Univ. Agric. Exp. Sta.* no. 159.)
P. tabaci (Wolf & Foster) Stapp; *Bacterium tabacum* Wolf & Foster, 1917; *Phytomonas tabaci* (Wolf & Foster) Bergey.
P. tolaasi Paine, 1919; *Phytomonas tolaasi* (Paine) Bergey.
P. utiformica Clara, 1932; *Phytomonas utiformica* Clara.
P. viburni (Thornberry & Anderson) Stapp; *Phytomonas viburni* Thornberry & Anderson, 1931.
P. viridiflava (Burkholder) Dowson; *Phytomonas viridiflava* Burkholder, 1930.
P. viridilivida (Brown) Stapp; *Bacterium viridilividum* Brown, 1915; *Phytomonas viridilivida* (Brown) Bergey.
P. woodsii (Smith) Stapp; *Bacterium woodsii* Smith 1911; *Phytomonas woodsii* (Smith) Bergey.

Xanthomonas Dowson, 1939

X. albilineans (Ashby) n.comb.; *Bacterium albilineans* Ashby, 1929; *Phytomonas albilineans* (Ashby) Magrou.
X. alfalfae (Riker, Jones & Davis) n.comb.; *Phytomonas alfalfae* Riker, Jones & Davis, 1933.
X. antirrhini (Takimoto) n.comb.; *Pseudomonas antirrhini* Takimoto, 1920; *Phytomonas antirrhini* (Takimoto) Magrou.
X. barbarea Burkholder, 1941.
X. begoniae (Takimoto) Dowson; *Bacterium begoniae* Takimoto, 1934; *Phytomonas begoniae* (Takimoto) Bergey.
X. campestris (Pammel) Dowson; *Bacillus campestris* Pammel, 1895; *Phytomonas campestris* (Pammel) Bergey.
X. carotae (Kendrick) Dowson; *Phytomonas carotae* Kendrick, 1934.
X. celebensis (Gaumann) n.comb.; *Pseudomonas celebensis* Gaumann, 1923; *Phytomonas celebensis* (Gaumann) Magrou.
X. citri (Hasse) Dowson; *Pseudomonas citri* Haase, 1915; *Phytomonas citri* (Haase) Bergey.
X. corylina (Miller *et al.*) n.comb.; *Phytomonas corylina* Miller *et al.* 1940.

X. cucurbitae (Bryan) Dowson; *Bacterium cucurbitae* Bryan, 1926; *Phytomonas cucurbitae* (Bryan) Bergey.

X. dieffenbachiae (McCulloch & Pirone) n.comb.; *Bacterium dieffenbachiae* McCulloch & Pirone, 1939; *Phytomonas dieffenbachiae* McCulloch & Pirone.

X. hederae (Arnaud) Dowson; *Bacterium hederae* Arnaud, 1920; *Phytomonas hederae* (Arnaud) Burkholder & Guterman.

X. holcicola (Elliott) n.comb.; *Bacterium holcicola* Elliott, 1930; *Phytomonas holcicola* (Elliott) Bergey.

X. hyacinthi (Wakker) Dowson; *Bacterium hyacinthi* Wakker, 1883; *Phytomonas hyacinthi* (Wakker) Bergey.

X. geranii (Burkholder) Dowson; *Phytomonas geranii* Burkholder, 1937.

X. gummisudans (McCulloch) n.comb.; *Bacterium gummisudans* McCulloch, 1924; *Phytomonas gummisudans* (McCulloch) Bergey.

X. itoana (Tochinai) n.comb.; *Pseudomonas itoana* Tochinai, 1932; *Phytomonas itoana* (Tochinai) Magrou.

X. juglandis (Pierce) Dowson; *Pseudomonas juglandis* Pierce, 1901; *Phytomonas juglandis* (Pierce) Bergey.

X. lactucae (Yamamoto) n.comb.; *Bacterium lactucae* Yamamoto, 1934; *Phytomonas lactucae* (Yamamoto) Bergey.

X. malvacearum (Smith) Dowson; *Pseudomonas malvacearum* Smith, 1901; *Phytomonas malvacearum* (Smith) Bergey.

X. nakatae (Okabe) n.comb.; *Bacterium nakatae* Okabe, 1933; *Phytomonas nakatae* (Okabe) Bergey.

X. nigromaculans (Takimoto) n.comb.; *Bacterium nigromaculans* Takimoto, 1927; *Phytomonas nigromaculans* (Takimoto) Magrou.

X. oryzae (Uyeda & Ishiyama) n.comb.; *Pseudomonas oryzae* Uyeda & Ishiyama, 1926; *Phytomonas oryzae* (Uyeda & Ishiyama) Magrou.

X. papavericola (Bryan & McWhorter) Dowson; *Bacterium papavericola* Bryan & McWhorter, 1930; *Phytomonas papavericola* (Bryan & McWhorter) Bergey.

X. phaseoli (Smith) Dowson; *Bacterium phaseoli* Smith, 1905; *Phytomonas phaseoli* (Smith) Bergey.

X. phormicola (Takimoto) n.comb.; *Bacterium phormicola* Takimoto, 1933; *Phytomonas phormicola* (Takimoto) Bergey.

X. pruni (Smith) Dowson; *Pseudomonas pruni* Smith, 1903; *Phytomonas pruni* (Smith) Bergey.

X. ricinicola (Elliott) Dowson; *Bacterium ricini* Yoshi & Takimoto, 1928; *Phytomonas ricinicola* (Elliott) Bergey.

X. rubrilineans (Lee *et al.*) n.comb.; *Phytomonas rubrilineans* Lee *et al.* 1925.

X. solanacearum (Smith) Dowson; *Bacillus solanacearum* Smith, 1896; *Phytomonas solanacearum* (Smith) Bergey.

X. tardicrescens (McCulloch) n.comb.; *Phytomonas tardicrescens* McCulloch, 1937.

X. translucens (Jones *et al.*) Dowson; *Bacterium translucens* Jones *et al.* 1917; *Phytomonas translucens* (Jones *et al.*) Bergey.

X. vasculorum (Cobb) Dowson; *Bacillus vasculorum* Cobb, 1893; *Phytomonas vasculorum* (Cobb) Bergey.

X. vesicatoria (Doidge) Dowson; *Bacterium vesicatorium* Doidge, 1920; *Phytomonas vesicatoria* (Doidge) Bergey.

X. vitians (Brown) n.comb.; *Bacterium vitians* Brown, 1918; *Phytomonas vitians* (Brown) Bergey.

Bacterium Ehrenberg, 1828 emend. Dowson, 1939

The generic name *Bacterium* has been used hitherto by various authors with different meanings; thus Chester (1901) used the term to denote sporing or non-sporing, non-motile, rod-shaped bacteria: Lehmann and Neumann (1927) defined *Bacterium* as non-sporing, motile or non-motile rod-shaped bacteria, and Elliott (1930) used the name for rod-shaped bacteria provided with polar flagella. I have restricted *Bacterium* to comprise Gram-negative, non-sporing, rod-shaped bacteria with peritrichous flagella and their non-motile variants (for a more comprehensive definition see Dowson, 1939).

B. amylovorum (Burrill) Chester; *Micrococcus amylovorus* Burrill, 1882; *Erwinia amylovora* (Burrill) Winslow *et al.*

B. ananas (Serrano) Burgwitz; *Bacillus ananas* Serrano, 1928; *Erwinia ananas* Serrano, 1928.

B. aroideae (Townsend) Stapp; *Bacillus aroideae* Townsend, 1901; *Erwinia aroideae* (Townsend) Holland.

B. carotovorum (Jones) K. B. Lehmann; *Bacillus carotovorus* Jones, 1901; *Erwinia carotovora* (Jones) Holland.

B. cassavae Hansford, 1936.

B. citrimaculans (Doidge) Burgwitz; *Bacillus citrimaculans* Doidge, 1917; *Erwinia citrimaculans* (Doidge) Magrou.

B. mangiferae (Doidge) Burgwitz; *Bacillus mangiferae* Doidge, 1915; *Erwinia mangiferae* (Doidge) Bergey.

B. marginatum McCulloch, 1921; *Phytomonas marginata* (McCulloch) Bergey.

B. phytophthorum (Appel) Burgwitz; *Bacillus phytophthorus* Appel, 1902; *Erwinia phytophthora* (Appel) Bergey.

B. pseudotsugae Hansen & R. E. Smith, 1937; *Phytomonas pseudotsugae* (Hansen & R. E. Smith) Bergey = *B. tumefaciens* Smith & Townsend.

B. rhaponticum Millard, 1924; *Phytomonas rhapontica* Millard, 1924.

B. rhizogenes Riker *et al.* 1930; *Phytomonas rhizogenes* Riker *et al.*

B. salicis Day, 1924; *Erwinia salicis* (Day) Bergey.

B. tracheiphilum (Smith) Burgwitz; *Bacillus tracheiphilus* Smith, 1895; *Erwinia tracheiphila* (Smith) Holland.

B. tumefaciens Smith & Townsend, 1907; *Phytomonas tumefaciens* (Smith & Townsend) Bergey.

REFERENCES

BERGEY *et al.* (1939). *Manual of Determinative Bacteriology*, 5th ed.

BREED, R. S. (1928). The present status of systematic bacteriology. *J. Bact.* XV, 145–63.

BREED, R. S. & CONN, J. H. (1936). The status of the generic term Bacterium Ehrenberg 1828. *J. Bact.* XXXI, 517–18.

BREED, R. S., CONN, J. H. & BAKER, J. C. (1918). Comments on the evolution and classification of bacteria. *J. Bact.* III, 445–59.

Brooks, F. T. (1928). *Plant Diseases*, p. 37.
Bryan, M. K. (1933). Bacterial speck of tomatoes. *Phytopathology*, xxiii, 897–904.
Burgwitz, G. K. (1936). *Bacterial Diseases of Plants*. Leningrad. Cited in *Rev. appl. Myc.* xvi, 302.
Burkholder, W. H. (1930). The genus *Phytomonas*. *Phytopathology*, xx, 1–23.
Burkholder, W. H. (1939). The taxonomy and nomenclature of the phytopathogenic bacteria. *Phytopathology*, xxix, 128–36.
Chester, F. D. (1901). *Manual of Determinative Bacteriology*.
Dowson, W. J. (1939). On the systematic position and generic names of the Gram-negative bacterial plant pathogens. *Zentralbl. f. Bakt.* ii Abt. C, 177–93.
Dowson, W. J. (1941). Systematics of gram-negative bacterial plant pathogens. *Chron. Bot.* vi, 197–8.
Elliott, C. (1930). *Manual of Bacterial Plant Pathogens*.
Escherich, T. (1885). Die Darmbakterien des Neugeborenen und Säuglings. *Fortschr. Med.* iii, 515, 547.
Gilbert, W. W. (1928). Control of cantaloupe diseases in Maryland. *Rept. Maryland Agr. Soc. and Maryland Farm Bureau Federation*, xii (1927), 401. Cited in Elliott's *Manual of Bacterial Plant Pathogens*, 1930, p. 84.
Johnson, D. E. (1930). The relation of the cabbage maggot and other insects to the spread and development of soft rot of Cruciferae. *Phytopathology*, xx, 857–72.
Jordan, E. O. & Burrows, W. (1941). *Textbook of Bacteriology*, 13th ed.
Kluyver, A. J. & van Niel, C. B. (1936). Prospects for a natural system of classification of bacteria. *Zentralbl. f. Bakt.* ii Abt. xciv, 369–403.
Lacey, M. S. (1939). Studies on a bacterium associated with leafy galls, fasciation and 'cauliflower' disease of various plants. Part III. Further isolations, inoculation experiments and cultural studies. *Ann. appl. Biol.* xxvi, 262–78.
Lehmann, K. B. & Neumann, R. O. (1927). *Bakteriologische Diagnostik*.
Migula, W. (1900). *System der Bakterien*.
Stapp, C. (1937). Weitere Beiträge zur Frage der Widerstandsfähigkeit verschiedenen Kartoffelsorten gegen Schwarzbeinigkeit und Knollennassfäule verursacht durch *Bacterium phytophthorum* Appel. *Angew. Botanik*, xix, 2, 141–52.
St John-Brooks, R. & Breed, R. S. (1937). Actions taken by the second International Microbiological Congress in London, 1936, regarding bacteriological nomenclature. *J. Bact.* iv, 445–7.
Topley, W. W. C. & Wilson, G. S. (1936). *The Principles of Bacteriology and Immunity*, 2nd ed. pp. 217, 218 and 549.
Wakker, J. H. (1884). Vorläufige Mittheilungen über Hyacinthenkrankheiten. *Bot. Centralbl.* xiv, 315–16.
Winslow, C.-E. A., Broadhurst, J., Buchanan, R. E., Krumweide, C., Rogers, L. A. & Smith, G. H. (1917). The families and genera of bacteria. *J. Bact.* ii, 505–66.
Winslow, C.-E. A. *et al.* (1920). The families and genera of bacteria. *J. Bact.* v, 191–229.

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NOTE ON THE OCCURRENCE OF *PYTHIUM MAMILLATUM* MEURS IN BRITAIN

By H. DUERDEN, *Department of Biology, Chelsea Polytechnic*

For many years I have obtained *Pythium debaryanum* for class demonstration purposes from mustard or cress seedlings sold for salad uses. In February 1942, some mustard seedlings were purchased in Horley, Surrey, and were kept well damped in a Petri dish in anticipation of the usual appearance of *P. debaryanum*. After a few days the seedlings showed heavy fungal infection. At first zoosporangia, then, later, sexual organs of *Pythium* appeared. After fertilization, however, the oogonial walls developed protuberances, and it was clear that the plant was not *P. debaryanum*.

Measurements were made of the reproductive organs, and these, together with their characters, agree with those given by Meurs (1928) for *P. mamillatum*, which was described by Meurs as being parasitic on beet seedlings in Holland. Matthews (1931) later recorded the occurrence of this species in the United States from a collection of sandy soil from a pot in which Venus fly traps were growing in the University greenhouse at Chapel Hill (University of North Carolina).

Attempts to get the fungus into pure culture were made by washing infected hypocotyls with distilled water, then placing them in a Petri dish with distilled water and later transferring portions to potato agar plates, but these efforts failed. Rich growth of *Mucor racemosus* only resulted.

The exact source of the fungus could not be determined, as the vendor of the seedlings had several sources of supply and could not state with certainty where any particular sample originated. This, however, is the first record of the occurrence of *Pythium mamillatum* in Britain.

REFERENCES

Matthews, V. D. (1931). *Studies on the Genus Pythium*, p. 99. University of North Carolina Press.

Meurs, A. (1928). Wortelrot, Veroorzaakt door Schimmels uit de Geslachten *Pythium* Pringsheim en *Aphomyces* de Bary. Dissertation, Baarn.

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THE NUMBERS OF FUNGI

By G. R. BISBY and G. C. AINSWORTH,
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Those wishing to ascertain the number of fungi generally turn to Saccardo's *Sylloge Fungorum*. The twenty-five volumes of that work contain 78,360 numbered specific entries, distributed approximately as follows: Myxomycetes, 750; Phycomycetes, 1500; Ascomycetes, 26,150; Basidiomycetes, 24,700; Fungi Imperfecti, 24,200; Bacteria, 700; Fungi Fossiles, 360. Species described as new during the last twenty-three years—an average of about 1000 per year—have not yet been compiled; it is safe to say that the *Sylloge*, if up to date, would contain about 100,000 specific names. Saccardo's main task, however, had to be the compilation of new descriptions; addition, not subtraction. The figure for Myxomycetes is about double the correct number; that for *Fusarium* (over 500) nearly ten times the number now accepted, and so on.

Table I gives the approximate number of genera of fungi described up to 1940, and indicates the numbers accepted as 'good' by competent authorities.

Table 1. *Numbers of genera and species of fungi*

Group	Numbers of generic names considered			Good species (approx.)
	Good, total	Good, monotypic	Synonyms	
MYXOTHALLOPHYTA				
Acrasiales	9	3	2	25
Labyrinthulales	3	1	0	10
Hydromyxales	4	3	6	15
Myxomycetes	63	35	77	400
Total	79	42	85	450
PHYCOMYCETES				
Chytridiales	87	56	48	300
Lagenidiales	7	4	1	20
Blastocladiales	5	1	2	20
Monoblepharidales	2	1	2	10
Saprolegniales	24	8	9	110
Peronosporales	12	2	21	200
Mucorales	42	15	54	230
Entomophthorales	23	12	6	100
Incertae Sedis	8	7	4	10
Total	210	106	147	1000

Table 1 (*continued*)

Group	Numbers of generic names considered: Good, total	Good, monotypic	Synonyms	Good species (approx.)
ASCOMYCETES				
Endomycetales	43	22	23	140
Taphrinales	6	1	7	130
Eurotiales	48	28	36	100
Myriangiales	43	30	23	100
Dothideales	134	70	104	620
Hemisphaeriales	173	86	77	1000
Erysiphales	74	45	51	900
Hypocreales	124	63	108	800
Laboulbeniales	118	42	17	1500
Sphaeriales	385	172	430	4400
Hysteriales	16	4	15	130
Phacidiales	49	25	42	250
Helotiales	260	134	186	1400
Pezizales	54	13	96	500
Tuberales	27	9	22	140
Incertae Sedis	10	10	21	10
Total	1564	754	1258	12,120
BASIDIOMYCETES				
Ustilaginales	34	12	29	700
Uredinales	123	45	108	4600
Tremellales	53	20	54	500
Agaricales				
Exobasidiaceae	3	1	1	15
Thelephoraceae	32	9	88	900
Clavariaceae	7	0	25	300
Hydnaceae	14	2	71	300
Polyporcaeae	19	1	173	1000
Boletaceae	6	2	38	220
Agaricaceae	80	10	284	4100
Hymenogastrales	47	24	28	290
Phallales	26	11	36	85
Lycoperdales	21	7	29	220
Sclerodermatales	21	11	34	130
Nidulariales	7	3	8	70
? Gasteromycetes	2	2	9	—
Total	495	160	1015	13,430
FUNGI IMPERFECTI				
Sphaeropsidales	501	281	294	5200
Melanconiales	83	39	87	1000
Moniliales	629	301	452	4100
Mycelia Sterilia	21	10	29	200
Total	1234	631	862	10,500
FUNGI INCERTAE SEDIS	2	2	136	—
Grand total	3584	1695	3503	37,500

The number of species now known

While the figure of 37,000 species of Eumycetes is fairly conservative, there are two respects in which it is still too large: (1) it is probable that a third of the Fungi Imperfecti have named perfect stages (proved or unproved,

known or unknown); (2) many species of fungi are not based on morphology alone—the generally accepted criterion for specific distinction—but (as in *Meliola*, *Septoria*, *Ustilago*) on host as well. We estimate that about 3500 Ascomycetes, 2500 Basidiomycetes (especially rusts and smuts) and 3500 Fungi Imperfecti can be classified as 'host-species'. This indicates that there are about 34,000 species now known, of which no more than 25,000 are based on morphology.

Many species of fungi show more variability than their descriptions admit. Large herbaria or compilations show a suspiciously large number of 'species' represented by but one collection or record, often a century old. Those who examine saprophytic fungi from various parts of the world find again and again a few common species.

The number of species not yet described

Many tropical and other areas, still to be explored mycologically, will yield thousands of species (especially 'host-species') of fungi. Bessey in his *Textbook* (1935) remarks that few of the 5,000,000 or so species of insects have been examined for the presence of Laboulbeniales, and predicts that many new species, genera, and even families of these fungi will be found. On the other hand it is possible that more collections will eliminate some names by showing that certain species are more variable than had been thought. Yet from under our feet the Zoopagaceae—a whole new family—has recently come to light. Our guess is that about a third of the fungi are now known; in other words, that there are about 100,000 species.

The number of genera known

Nature may make species, but man has made the genera. By adding columns one and three in Table 1 the total number of generic names proposed up to 1940 is obtained; for all fungi (including Myxothallophyta), this figure exceeds 7000. (Clements and Shear, *The Genera of Fungi*, give some 4600 generic names of Eumycetes and 460 of lichens.)

It is probable that not more than one out of two proposed new genera is 'good', one out of three new species. Nearly half (47·2 %) of the genera accepted for Eumycetes, or for all fungi, are monotypic. Mycologists seem inclined to erect a new genus for each species except 'host-species'—and even for some of them. Phanerogamic botanists show a similar inclination: Willis (*The Course of Evolution*, 1940) records that 4853 of the 12,571 accepted genera of vascular plants (up to 1915) are monotypic, i.e. 38·6 %.

Many mycologists feel that the taxonomy of fungi is in greater need of synthesis than of more analysis; and a competent study of old genera and species, with much elimination.

The number of fungi in Britain

Table 2 gives the large figure of 9000 species of fungi (including Myxomycetes) recorded from Britain.

The *London Catalogue* lists 2362 Spermatophytes plus Pteridophytes now native in Britain. In comparing the two figures it must be remembered

that (1) mycologists include introduced fungi; (2) they seldom remove a name from their lists, and numerous 'species' have not been seen for a century; (3) perhaps 400 fungi are recorded in both perfect and imperfect stages; (4) many host-species are (rightly) included, and a large number of mistakes.

Perhaps 6000 of the 9000 names represent good species present in Britain to-day. We suggest that a new enumeration of British Fungi be started, based only on such specimens as can now be found, definitely identified, and preserved in available herbaria.

Table 2. *Number of species recorded from Britain*

Group	No.	Source of data
Myxomycetes	215	Lister's *Mycetozoa*
Phycomycetes	250	*Trans. Brit. Mycol. Soc.* v+50%
Discomycetes	900	„ „ „ „ iv and suppls.
Pyrenomycetes	1423	„ „ „ „ xxiv
Ustilaginales	70	„ „ „ „ xxiv
Uredinales	330	M. Wilson *in litt.*
Higher Basidiomycetes	2689	Rea (1922), and suppls.
Coelomycetes	1800	Grove (1935, 1937)
Hyphomycetes	1208	*Trans. Brit. Mycol. Soc.* xxv
Dermatophytes	15	'Net' est. by P. H. Gregory, *in litt.*
Yeasts, etc.	100	Est. by writers
	9000	

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NEW AND INTERESTING PLANT DISEASES

By W. C. MOORE, *Plant Pathological Laboratory, Harpenden*

(With Plate I)

13. *Fusarium* disease of maize seedlings grown in nutrient solution

In the summer of 1937 a London firm, interested in methods of intensive cultivation, inquired about the suppression of moulds that were proving troublesome on cereal seedlings raised, for use as cattle fodder, by sprouting the grain in cabinets containing nutrient solutions. Efforts made to overcome the trouble by the adoption of better hygienic methods proved tolerably successful with barley, even when the seed was untreated. No improvement was obtained with maize, however, although, as an additional precaution, the seed was well washed with water and then soaked in a solution of potassium sulphide (½ oz. per gallon of water) for sixteen hours before being placed in the cabinets. This treatment retarded, but did not prevent mould development.

It was suspected that something other than saprophytic moulds must be present, and when specimens of the 'mouldy' maize seedlings were obtained towards the end of the year, nearly all of them were found to be vigorously attacked by *Fusarium moniliforme* Sheldon. The roots and frequently the bases of the young stems were brown and rotten, and the leaves were rapidly dying back from the tips. *Fusarium* was present in abundance on the affected parts, and here and there species of *Penicillium* and *Aspergillus* were also fructifying.

According to Wollenweber and Reinking (1935), *Fusarium moniliforme* is largely a 'warm-district' fungus, occurring as a parasite on maize mainly in tropical and subtropical areas. It often causes severe losses in the southern parts of the United States of America, and in Louisiana as many as 50 % of the seeds may be infected in some seasons. The surface of the seed becomes contaminated with spores, or the fungus may enter the grain and penetrate to any part of it.

The seed used in the sprouting cabinets was obtained from the Argentine and some of it must have been infected with *F. moniliforme*. Steeping the grain in potassium sulphide probably killed any spores on the surface of the seed, but had little or no effect on the mycelium in the tissues, and under the warm, humid conditions prevailing in the cabinets, the fungus developed rapidly and passed from the infected seed into the developing roots and stems. Moreover, the trays in the cabinets were so loaded with tightly packed grain that there was every opportunity for the fungus to pass rapidly from the seedlings primarily infected, to the healthy roots and stems developing from uninfected seed.

Investigations carried out in Illinois (Report, 1931) had indicated that 90 % of the *F. moniliforme* present in or on maize seed is killed when the seed is artificially dried in a Carrier air-conditioning apparatus at 43–54° C. (110–130° F.). Experiments along the same lines were therefore suggested to the firm and these were carried out. Within a month or two it was reported that the difficulties had been overcome, as far as the *Fusarium* was concerned, by heating the previously soaked seed to a temperature of 54° C. (130° F.) for twenty minutes. This treatment, however, had little or no effect on the subsequent development of *Penicillium* in the cabinets.

14. *Penicillium* rot of *Scilla* bulbs

Species of *Penicillium* have been found associated with rotting in bulbs of *Scilla* on several occasions. *Penicillium Gladioli* McCull. & Thom was identified by Miss McCulloch (Dean, 1930) on Dutch bulbs intercepted at Philadelphia in 1930. Later, MacFarlane (1939) found *P. cyclopium* Westl. causing a partial or complete rot of bulbs of *Scilla campanulata* var. *albida* imported into Scotland from Holland, and she showed that this fungus acted as a wound parasite of *Scilla* bulbs under moist conditions, when the storage temperature was relatively high (16–20° C.). Her results were confirmed by Singh (1941), who isolated the same species from imported bulbs of *S. nutans* and *S. campanulata*, as well as from bulbs of bluebells collected in woods in England. He proved, too, that the fungus from *Scilla* could attack wounded *Lilium* and *Iris* bulbs, and that *Penicillium corymbiferum* from rotting bulbs of *Lilium regale* was pathogenic to damaged *Scilla* bulbs.

In September 1941 I found a species of *Penicillium* associated with a storage rot that had affected some 10 % of 8000 bulbs of *Scilla patula excelsior* and *S. hispanica alba* grown in Buckinghamshire. Large, lateral, sunken lesions up to $\frac{3}{4}$ in. across, and often coalescing, were present on most of the diseased bulbs, but occasionally the basal plate only was affected. The diseased areas were frequently completely covered with a copious growth of *Penicillium*, but where this was absent or sparse, the lesions were pale brown and the outer skin was puckered into yellow folds or blisters. In some bulbs the rot was superficial, extending only about $\frac{1}{8}$ in. into the outer scale, with the collapsed cells forming a buff-coloured, spongy layer; in others, it was wet, soft, deep brown, and penetrating. A single species of *Penicillium* was isolated in pure culture from the surface of the lesions and from the rotted tissues, and Mr G. Smith kindly identified it for me as a strain of the *corymbiferum-hirsutum* group. On Czapek agar it produced numerous very characteristic blood-red drops. The colour on this medium was a little less bluish than that of typical *corymbiferum*, and probably clearer than that of *hirsutum*. Smith (*in litt.*) agrees with Thom (1930) that these two forms can be regarded as different strains of the same species.According to Thom, the original description of *Penicillium hirsutum* Dierckx (1901) was worthless, but the species was adequately described by Biourge (1923), who, to judge from his account, probably had access to authentic material. If so, the correct name of the fungus is *P. hirsutum* Dierckx, despite the fact that *P. corymbiferum* Westling (1911) antedates Biourge.

15. Bulb canker of garlic (*Allium sativum* L.), caused by *Helminthosporium Allii* Campanile

In April 1942 Mr C. J. Hickman sent me a few diseased cloves (bulblets) of white garlic (*Allium sativum* L.) that had been picked out from a consignment of bulbs imported from the Argentine and destined, in part, for planting in Worcestershire. The amount of disease present in the consignment was slight for, in half a hundredweight of bulbs examined, Mr Hickman had found less than 1 % affected.

The most striking feature of the disease on the individual clove was the occurrence of a black, sunken, canker-like area, $\frac{1}{2}$ in. or so across, at the top or on the side of the fleshy scale, immediately below the membranous, silky white, enveloping scale (Pl. I, fig. 1). The black appearance was due to the presence on the surface of the lesion of a dense felt of mycelium and spores of a species of *Helminthosporium*. In one or two instances the whole of the inner surface of the outer membranous scale had become sprinkled with spores and mycelium from the canker lesion, and externally the whole clove looked blackened. On some cloves, however, the fungus had not fruited and the lesion was then pale brown or brown with a greyish centre.

The conidiophores of the fungus were comparatively rigid, straight or bent, brown, septate, up to 120μ or more long, and about 6μ wide at the base. The conidia were acropleurogenous, a single one being present at each bend or joint of the conidiophore as well as at its tip. The conidia (Pl. I, fig. 2) varied much in shape and size. The majority were long, cylindric, smooth, usually tapering at the rounded ends, brown, with 4–8 (usually 4–5) transverse walls, not constricted at the septa, and measuring 30–41 × 9–11μ (average 35 × 9·5μ). Many conidia, however, were shorter and relatively broader (21–26 × 10–12μ), ellipsoidal, with only 2–3 transverse walls, while a comparatively small number were quite irregular in shape, being curved and 'waisted', or bent abruptly in the middle or towards one end to give a broad and shallow **V**-shape or even a **Y**-shape. Occasionally these abnormal conidia showed a single longitudinal or radial wall, and in one or two instances the penultimate cell had given rise to a typical brown septate conidiophore about 50μ long. The characters of the fungus, and the symptoms of the disease associated with it, corresponded very closely to those described and illustrated by Campanile (1924 *a*, *b*) for *Helminthosporium Allii* Campanile, with which the present fungus is believed to be identical.

Campanile described a new disease of garlic occurring in the Fucino district of Italy, and showed that it was due to a species of *Helminthosporium*, which she regarded as new and named *H. Allii*. The disease attacked the bulbs, leaves and flowering scape of white garlic, especially the larger bulbs and more vigorously growing plants. It was not seen on red garlic, though this variety became infected when cloves of it were inoculated artificially, if the outer covering scale was first removed. Even then, however, the red variety showed some resistance to the fungus. Campanile referred to, and briefly described, an unidentified species of *Pleospora* that was commonly present on garlic plants attacked by the *Helminthosporium*. She thought the

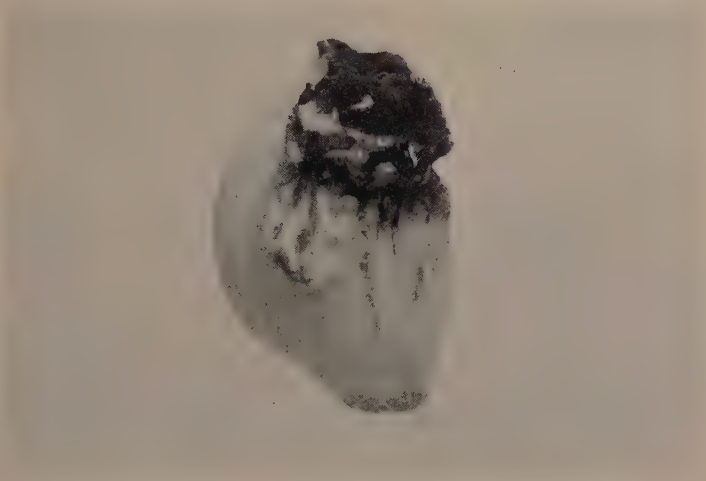

Fig. 1

Fig. 2

Photos by W. F. Buck

two fungi were probably related, but did not succeed in obtaining the *Pleospora* in pure culture. No perithecia were present on the diseased cloves I examined.

I could trace no other record of *Helminthosporium Allii*, but a bulb rot of garlic due to an unidentified species of *Helminthosporium* was reported from Texas in 1937 (Wood & Nance, 1939) and in the two succeeding years (Nance, 1940 & 1941), and some years before, Walker and Lindegren (1924) had referred to a small-spored species of *Helminthosporium* that commonly caused dark-coloured blotches on the outer scales of White Globe onions in America, though it was never seen on the coloured varieties.

REFERENCES

Biourge, P. (1923). Les moisissures du groupe *Penicillium* Link. Étude monographique. *La Cellule*, xxxiii, fasc. 1, 157.

Campanile, G. (1924*a*). Su di una nuova malattia dell' aglio dovuta ad '*Helminthosporium allii*' nov.sp. *Nuova Ann. Minist. Agric.* iv, 87–106.

Campanile, G. (1924*b*). Richerche sopra le condizioni di attacco e di sviluppo di *Helminthosporium allii* su aglio. *Staz. sperm. agrar. Ital.* lvii, 413–28.

Dean, H. S. (1930). Plant quarantine notes. *Plant Dis. Reptr.* xiv, 247.

Dierckx, R. P. (1901). Un essai de révision du genre *Penicillium* Link. Note préliminaire. *Ann. Soc. sci. Brux.* xxv, 83–89.

MacFarlane, Christina S. (1939). A rot of Scilla bulbs caused by *Penicillium cyclopium* Westling. *Trans. bot. Soc. Edinb.* xxxii, 542–7.

Nance, Nellie W. (1940). Diseases of plants in the United States in 1938. *Plant Dis. Reptr. Supp.* cxix, 198.

Nance, Nellie W. (1941). Diseases of plants in the United States in 1939. *Plant. Dis. Reptr. Supp.* cxxviii, 250.

Report (1931). A year's progress in solving farm problems of Illinois, 1930–31. *Rep. Ill. agric. Exp. Sta. for year ending* 30 *June* 1931, xliv, 214–17.

Singh, B. (1941). Bulb rot of *Scilla nutans* caused by *Penicillium cyclopium* Westling. *Trans. Brit. myc. Soc.* xxv, 194–9.

Thom, C. (1930). *The Penicillia*, p. 425.

Walker, J. C. & Lindegren, C. C. (1924). Further studies on the relation of onion scale pigmentation to disease resistance. *J. agric. Res.* xxix, 510.

Westling, R. (1911). Über die grünen Spezies der Gattung *Penicillium*. *Svensk. Bot. Tidskrift*, v, 82–90. See also *Arkiv for Botanik*, ii, 1–156.

Wollenweber, H. W. & Reinking, O. A. (1935). *Die Fusarien, ihre Beschreibung, Schadwirkung und Bekämpfung*, p. 297. Berlin.

Wood, Jessie I. & Nance, Nellie W. (1939). Diseases of plants in the United States in 1937. *Plant Dis. Reptr. Supp.* cx, 276.

EXPLANATION OF PLATE I

Fig. 1. Clove (bulblet) of *Allium sativum* L. with apical part attacked by *Helminthosporium Allii* Campanile. The outer enveloping skin has been removed.

Fig. 2. Spores and mycelium of *Helminthosporium Allii* Campanile. ×350.

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TWO NEW SPECIES OF *ASPERGILLUS*

By GEORGE SMITH, *from the Division of Biochemistry, London School of Hygiene and Tropical Medicine, University of London*

(With Plates II and III)

Aspergillus avenaceus n.sp. (Cat. No. 155). Pl. II, figs. 1–3.

The fungus was isolated in March 1938 by Dr G. E. Turfitt, then working in this Department, from seed peas.

In colour and general appearance of the conidial heads the new species strongly resembles *A. ochraceus* Wilhelm or, perhaps more nearly, *A. sulphureus* Fres. The character of the stalks, however, precludes relationship with the latter group. They show no trace of roughness, even under the highest magnification, but are more or less brittle, with a tendency to split longitudinally when sharply bent or broken, suggesting affinity with the *A. niger* series. The most striking feature of the mould is the production of large black sclerotia, quite unlike the usual types found in either the *A. ochraceus* or the *A. niger* series.

Dr Charles Thom, of the U.S. Department of Agriculture, has very kindly examined the fungus and suggests that its nearest relation is *A. alliaceus* Thom & Church, from which, however, it differs materially. It appears to be a further addition to the series of species, including *A. Schiemanni* Thom & Church, *A. cinnamomeus* Schiemann, and possibly some of the pure white forms at present included in *A. candidus* Link, which are morphologically related to the *A. niger* series, but in which the dark colouring matter is almost or entirely absent. Dr Thom also reports that *A. alliaceus*, in which the sclerotial phase usually predominates, may be induced, by suitable 'poisoning', to produce abundant conidial heads. *A. avenaceus*, on the other hand, when grown on most solid culture media, is mainly conidial with comparatively few sclerotia, but becomes almost entirely sclerotial on Czapek's solution containing glucose as source of carbon.

Diagnosis

Aspergillus avenaceus sp.nov. coloniis in agaro Czapekii late crescentibus, paulo floccosis, albis dein luteolis aut avenaceis, aliquando leviter viridulis sed numquam vere viridibus, reverso carneolo; capitulis globosis, 400–600 μ diam., in cultis senibus incompositis cum diametris maximis ad 1000 μ; stipitibus glabris, fractis cum fissione in longitudinem, 4–5 mm. longis et 18–30 μ diam., parietibus 2·5–4 μ crassis; vesiculosis globosis, interdum leviter applanatis, crassimuratis, ad 185 μ diam.; sterigmatibus primariis 22–50 × 6 μ, secundariis 11–13 × 4 μ; conidiis glabris, ellipsoideis, 4–6 (6·5) × 3·2–4 μ; sclerotiis nigris vel griseofuscis, plerumque prope ampulliformibus, saepe bifurcis, 2–3 mm. long., frequentissimis in cultis in aqua Czapekii glucoso commixto.

Fungus in seminibus exsiccatis *Pisi sativi* inventus, non parasiticus.

Colonies on Czapek agar (with saccharose) spread rapidly, at first white and slightly floccose, then dull yellow to ochraceous, often with a slight greenish tinge but never definitely green, with large prominent conidial heads on long stalks; reverse pale dirty pink; sclerotia appearing usually in seven to ten days, not very numerous, often produced in concentric zones.

On Czapek agar with glucose, sclerotia are much more numerous and often larger.

On wort agar or potato agar colonies spread rapidly, with abundant production of conidial heads and with sclerotia appearing only after several weeks, and then somewhat sparsely.

On Czapek's solution, with 5 % glucose as source of carbon, growth consists at first of a thin mat of dirty white, slightly floccose mycelium, soon followed by the development of enormous numbers of black sclerotia, covering the original mycelial felt almost completely, with conidial heads produced tardily and only in isolated patches.

On Raulin-Thom solution (i.e. Raulin's solution with ammonium tartrate in place of ammonium nitrate) colonies are floccose, sporing tardily and somewhat sparingly, with very large viscous drops, and with the solution gradually becoming exceedingly viscous; no sclerotia are formed.

Conidial heads globose, 400–600μ in diam., tending to split in age to form several roughly columnar masses of conidial chains, with greatest diam. up to 1000μ; stalks without any trace of pitting or roughness, tending to split when bent or broken, 4–5 mm. long and 18–30μ in diam., with walls 2·5–4μ thick; vesicles globose, sometimes slightly flattened, thick-walled, up to 185μ in diam.; primary sterigmata varying considerably in length in different heads, 22–50 × 6μ, secondary sterigmata more uniform, 11–13 × 4μ; conidia smooth, definitely ellipsoid, 4–6 (6·5) × 3·2–4μ; sclerotia dark greyish brown to black, irregular but mostly more or less flask-shaped, often forked and resembling two-necked perithecia, 2–3 mm. long.

Species related to *A. alliaceus* Thom & Church but distinguished therefrom by its abundant production of conidial heads and by its larger, definitely ellipsoid conidia. The specific name chosen as descriptive of the conidial colour.

Aspergillus proliferans n.sp. (Cat. No. 82), Pl. II, fig. 4 and Pl. III, figs. 5–6

This species was received in October 1927 from the British Cotton Industry Research Association. It was originally isolated from cotton, but its exact history is unknown.

An examination at the time showed the presence of scanty conidial heads of the normal *Aspergillus* type, and of numerous sporing structures which apparently bore little resemblance to any *Aspergillus*. Pl. II, fig. 4 and Pl. III, fig. 5, from photomicrographs taken in January 1928, show the normal and abnormal types of head. Recent study of the mould has shown that it is morphologically stable, and still shows all the characteristics it had when first isolated. The abnormal heads are now interpreted as owing their bizarre appearance to variously transformed sterigmata. The general

appearance of colonies, the rate of growth, the structure of normal conidiophores and the size and markings of the conidia all suggest affinity with the *A. glaucus* group. Proliferation is fairly commonly observed in species of this group, but it is unusual to find, as in the new species, abnormal heads predominating. No perithecia have been observed, but this does not necessarily preclude relationship with the *A. glaucus* group. Recent work by Thom and Steinberg (1939, 1940) has shown that stable mutants from various species of *Aspergillus* can be obtained by chemical stimulation, the mutants from *A. glaucus* showing partial or total suppression of the perfect stage, and it is suggested that non-perithecial strains which are periodically isolated from natural sources have arisen in a similar way.

Diagnosis

Aspergillus proliferans sp.nov., coloniis in agaro Czapekii lentissime crescentibus, primo albis dein lutescentibus denique glaucis, reverso luteobrunneo; in musto ex hordeo cum agaro celeriter sed tamen lente crescentibus, mycelio aerio albo dein luteo aurantioque, floccoso, cum partibus fertilibus glaucis dein griseis tarde apparentibus, reverso luteo; capitulis veris laxis radiatis; stipitibus glabris, ferme septatis, cum parietibus tenuibus, 4–14μ diam.; vesiculosis subglobosis vel obconicis vel solum extremis stipitibus leviter crassatis; sterigmatibus in una serie, 8–11 × 3·5–6μ sed saepe elongatis, septatis, parvis capitulis secundariis ferentibus, vel cum partibus superioribus inflatis, ad 20μ diam.; conidiis globosis subglobosisve, asperulis, fuscis, 5–9·5μ diam.; peritheciis ignotis.

Fungus *A. glauco* propinquus, in gossypio inventus, British Cotton Industry Research Association, Mancunii.

Colonies on Czapek agar spreading very slowly, with growth at first largely submerged, then with matted floccose aerial mycelium, white changing to yellowish shades, sporing tardily, with conidial areas grey-green, reverse yellowish brown; on wort agar growing slowly but better than on Czapek, with mycelium white then yellow and finally orange and tardy development of grey-green to grey conidial areas, becoming more deeply floccose in age especially at shallow end of slope, reverse yellow; normal conidial heads loosely radiate; stalks smooth, thin-walled, usually with one or two septa, 4–14μ diam.; vesicles occasionally almost globose, more frequently obconical or mere thickenings of the ends of the stalks, up to about 20μ in diam.; sterigmata when normal, in one series, 8–11 × 3·5–6μ, often elongate, septate and bearing small secondary heads, frequently resembling heads of monoverticillate *Penicillia*, or with upper portion much swollen and appearing almost as a very large, thick-walled conidium with long connective, up to 20μ diam., with normal and swollen sterigmata often appearing in the same head; conidia globose or subglobose, rough, fairly dark-coloured, 5–9·5μ in diam.; perithecia not found.

Species related to the *A. glaucus* series, and abnormal in lacking the perfect stage and in the unusual tendency to proliferation of sterigmata.

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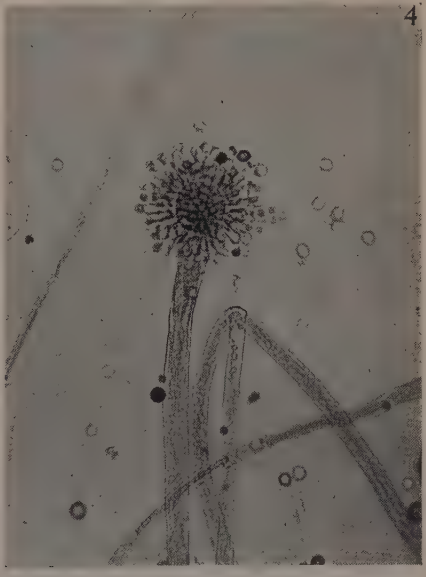
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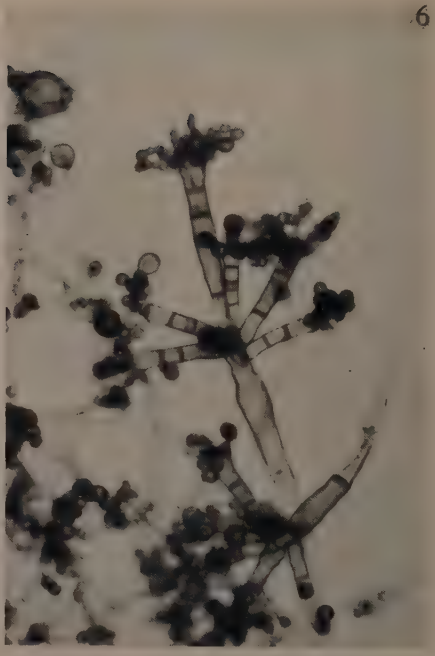
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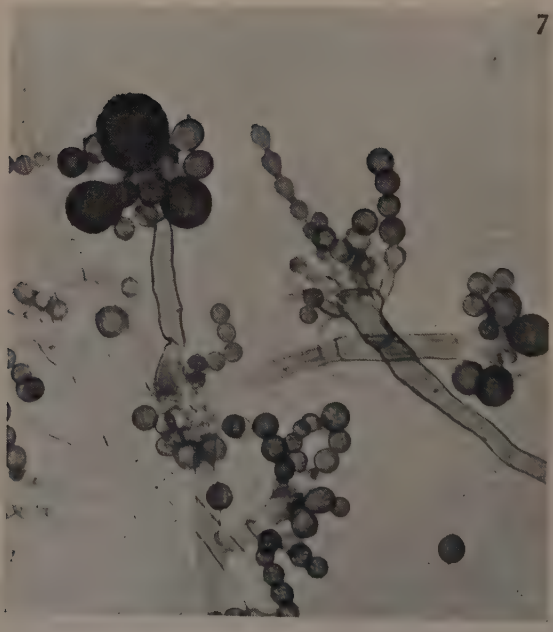
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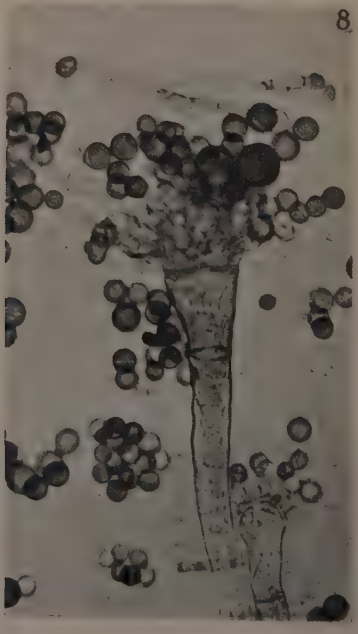
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REFERENCES

Steinberg, R. A. & Thom, C. (1940). Chemical induction of genetic changes in Aspergilli. *J. Heredity*, xxxi, 61–3.

Thom, C. & Steinberg, R. A. (1939). The chemical induction of genetic changes in fungi. *Proc. Nat. Acad. Sci. (U.S.A.)*, xxv, 329–35.

EXPLANATION OF PLATES

Fig. 3 is from a photograph of dry, unmounted specimens. All the remaining figures are from photographs of specimens mounted in lacto-phenol.

Plate II

Fig. 1. *Aspergillus avenaceus*. Typical head. × 150.

Fig. 2. *A. avenaceus*. Broken stalk showing characteristic splitting. × 250.

Fig. 3. *A. avenaceus*. Sclerotia. × 12.

Fig. 4. *A. proliferans*. Normal type of head. × 250.

Plate III

Fig. 5. *A. proliferans*. Very abnormal head. × 250.

Fig. 6. *A. proliferans*. Head with cluster of secondary stalks in place of sterigmata. × 250.

Fig. 7. *A. proliferans*. Small head with normal sterigmata and head with swollen cells. × 500.

Fig. 8. *A. proliferans*. Head with one swollen sterigma, the rest normal. × 500.

(*Accepted for publication* 27 *June* 1942)

THE MEASUREMENT OF PLANT DISEASES IN THE FIELD

PRELIMINARY REPORT OF A SUB-COMMITTEE OF THE SOCIETY'S PLANT PATHOLOGY COMMITTEE

By W. C. MOORE

(With 2 Text-figures)

In 1933 the Society's Plant Pathology Committee organized a symposium on the measurement of disease intensity, at which methods devised by research workers for use in investigating certain well-known diseases were described and discussed (*Trans. Brit. myc. Soc.* XVIII, 1933, 174). Since that time the need to improve existing methods of recording the amount of disease, in order to obtain precise information about the general prevalence and intensity of diseases in Great Britain in relation to locality, season, soil and other factors, has become increasingly recognized. In an effort to satisfy this need, the Plant Pathology Committee called a special meeting at Rothamsted (Harpenden) in February 1941 for a full discussion on the subject, to which a number of plant pathologists were invited. At this meeting it was agreed that the Committee should attempt to evolve simple but reliable standard methods of recording disease quantitatively in the field; and a sub-committee consisting of W. Buddin (Secretary), F. C. Bawden, R. W. Marsh, W. C. Moore and the Secretary of the Plant Pathology Committee (P. H. Gregory) ex officio, was appointed to make provisional recommendations for immediate adoption.

It was realized from the start that tentative proposals, necessarily based mainly on theoretical considerations, might need to be modified considerably in the light of practical experience extending perhaps over several years. Appreciating this, the sub-committee prepared a flexible scheme which, while acting as a framework and serving as a guide, permitted ample scope for individuality and allowed for necessary adjustments. The scheme was explained at a general meeting of the Society held in April (Bawden, 1941), and shortly afterwards a letter asking for active collaboration was sent to those interested, together with copies of the proposals for 1941. Printed forms specially designed for recording results were also made available. As a result, over 1200 estimates of disease intensity were received during 1941, and the sub-committee gratefully acknowledges the help given to them in this work by G. C. Ainsworth, A. Beaumont, S. D. Garrett, Miss M. D. Glynne, D. E. Green, C. J. Hickman, R. Hull, E. C. Large, M. H. Moore, N. C. Preston, I. F. Storey, R. E. Taylor, A. G. Walker, Mrs M. A. Watson, J. H. Western, W. A. R. Dillon Weston, R. K. S. Wood* and R. C. Woodward.

* Mr Wood's observations were carried out during the three months' tenure of a special grant made by the Ministry of Agriculture and Fisheries, to whom grateful acknowledgement is made.

The methods employed in 1941

Whether the measurement of disease is considered as an end in itself, regardless of the uses to which the results might be put, or as a means of estimating, for instance, the rate of progress of disease, the efficacy of protective control measures or the monetary losses due to diseases of economic plants, the methods employed should be accurate. One of the chief aims of the sub-committee, therefore, was to devise quantitative methods based on crop sampling. Such methods, though to be preferred wherever possible, might consume too much time to be of practical value when large numbers of crops are to be examined. It is therefore also desirable to test the reliability of rapid visual estimates against the sampling methods, much in the same way as Horsfall and Heuberger (1942) have done for a leaf disease of tomato. For general purposes it is essential above all to make sure that the results obtained on the same crops by different observers, using the same or different methods, are strictly comparable.

The work carried out in 1941 was regarded as mainly exploratory in nature. Attention was directed to six diseases of crops important in war time, namely, Loose Smut of wheat, Blight and Virus diseases of potato, Virus Yellows and Downy Mildew of sugar beet, and Brown Rot of apple. They were selected in part because of ease in recording. Observations on Take-All and Eyespot of wheat, and on apple Scab, were also invited because of their special appeal in current research.

It is scarcely necessary to give here full details of the sampling methods employed; they were regarded as tentative and were, indeed, modified during and after the season, as occasion demanded.

The same general procedure was recommended for potato, sugar beet and wheat. Two traverses were made, and ten samples taken on each traverse. For potato and sugar beet the sample consisted of ten consecutive plants in a drill, and the ten samples were taken at convenient distances along the diagonals of the field. With wheat, each sample consisted of two one-yard lengths of drill row, consecutive but in adjacent rows. Moreover, in order to avoid unnecessary damage to the crop, the traverses were taken in the direction of drilling instead of along the diagonal. The traverses were begun from the side of the field at points one-fifth and four-fifths of the width of the field, the first sample was taken not less than fifteen paces from the edge of the field and, after each sample, the observer side-stepped three paces and proceeded along the row to the next sampling place. With all diseases except potato blight it was sufficient to record the numbers of infected and healthy plants (or tillers) in each sample. For potato Blight each plant in the sample was given a symbol from 0 to 6, depending on the numbers of Blight spots present on the leaflets or, at the higher levels, on the amount of leaf area destroyed.

Brown Rot of apple was recorded a fortnight or so before harvest. A count was taken of the number of affected apples among fifty fruits chosen at random from each of ten trees taken at random. Sampling for apple Scab was carried out in July and was based on a minimum of five hundred leaves collected by picking fifty leaves at random from each of

ten trees, scattered through the orchard. The leaves were graded by means of the Tehon scale (Tehon & Stout, 1930).

The figures for intensity of disease obtained by these sampling methods were recorded on specially printed forms (Fig. 1), together with the locality, variety, size of field, stage of development of the plants (recorded as symbols A, B, C, etc., each corresponding to a standard description), control measures and other relevant information. Reports were made on all fields examined, whether or not disease was present in them.

The results obtained

As already indicated, the primary object of the Committee is to devise, test, and ultimately to recommend methods of measuring disease. The extent to which any methods evolved are approved and adopted as standards, however, will depend mainly on the results they yield and the uses to which those results can be put. It may therefore be profitable to summarize the encouraging results obtained in 1941 and to illustrate a few of the ways in which they might be used to advantage.

PLANT DISEASE REPORT

Crop Date Disease

Address

Variety

Size of Field

Stage of Development of Plants

Control measures:—

Infection Data:—

Remarks:—

Fig. 1.

Potato Blight (*Phytophthora infestans* (Mont.) de Bary). The year was a favourable one for observation on this disease, and after the large number of reports received from collaborators had been considered clear indications of future possibilities became apparent.

The date of attack. Apart from their intrinsic value, the dates on which Blight is first recorded, or when it reaches a certain intensity in different districts, provide evidence for or against the belief that Blight begins in the west and spreads gradually to the east and north. First records were noted in Cornwall (28 July), Evesham (before 2 September), Reading (14 August), Harpenden (20 August) and Spalding (22 August), and the approximate dates when most plants of a variety of medium susceptibility were one-third defoliated by Blight were recorded from West Devon (30 August), Central Devon (23 August), East Devon (6 September), Evesham (14 September), Reading (27 August), Harpenden (6 September), and Spalding (9 September).

The course of epidemic attacks. Much greater scope is afforded when several records are taken on the same crop. Fig. 2 shows a graph in which the

degree of intensity of attack is plotted against time for four districts. Only the data for one field of Majestic in each district is included, and despite the fact that the recording method had not been stabilized and the frequency of observation varied with the district, the graph clearly demonstrates the relatively late appearance and rapid spread of Blight in 1941 in all four areas. The available records on the course of the disease at the Seale-Hayne Agricultural College in 1932 and 1937 are included to show the contrast in slope and position along the time scale that can be expected in other seasons. It is obvious that with the adoption of standard methods of

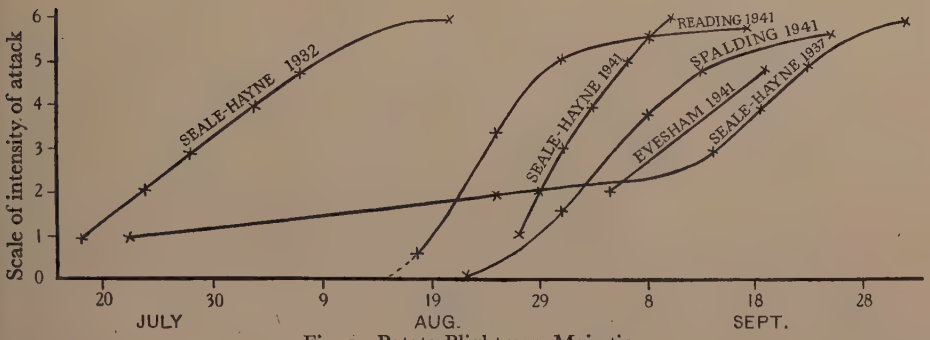

Fig. 2. Potato Blight var. Majestic

recording, applied in many more districts, and with the accumulation of similar graphs over a period of years, invaluable information can be collected about potato Blight or, indeed, about many other epidemic diseases.

Varietal susceptibility in the foliage. From the records obtained it was possible to construct the following list of varieties arranged in descending order according to the susceptibility of the foliage to Blight. The list is compiled mainly from the records made in south-west England, but the position of some varieties was confirmed in other districts.

Early varieties	Second early and main-crop varieties	
Arran Pilot, D, E	King Edward, D, E, R	Arran Banner, D, E, R
May Queen, D	Up-to-date, D	Golden Wonder, D
Epicure, D	British Queen, D	Red Skin, E
Sharpe's Express, D	Dunbar Rover, R	Arran Chief, E, R
	Majestic, D, E, R, S	Gladstone, D, E, R
	Doon Star, D, E, S	Dunbar Archer, D
	Great Scot, D, E, R	Kerr's Pink, D
	Red King, D	President, D

D=Devon and Cornwall; E=Evesham; R=Reading; S=Spalding area

Relative susceptibility of Scotch and once-grown seed. In five well-separated fields in Berks and Oxon it was possible to compare the development of Blight on adjacent crops of Majestic grown from fresh Scotch and English once-grown seed. The results showed that in general Blight was slightly worse on the once-grown crops.

There is no doubt that still further information of practical value about

Blight can be deduced from records made on a common plan. For instance, the observations carried out in Devon and Cornwall provided most significant and concise data for comparing the protective effects of different spray treatments.

Potato Virus Diseases. 119 crops were examined for Leaf Roll, Severe Mosaic (secondary infection with potato virus *Y*) and Leaf-Drop Streak (primary infection with potato virus *Y*). They cannot be regarded as a representative sample of the potatoes grown in England, because they contained only seven crops from twice-grown seed, but they yielded results from which trustworthy conclusions can be drawn.

Table 1

Seed	Disease category (% plants infected)	Number of crops in each category: Leaf Roll	Severe Mosaic	Leaf-Drop Streak	Total severe disease
	SOUTH OF THE WASH				
Certified (32 crops)	0·0–0·4	5	27	22	3
	0·5–2	16	3	6	13
	2·1–8	9	1	4	12
	8·1–20	1	1	0	3
	21 –60	1	0	0	1
Once-grown (41 crops)	0·0–0·4	3	22	21	1
	0·5–2	12	16	7	9
	2·1–8	12	3	5	12
	8·1–20	8	0	7	8
	21 –60	6	0	1	11
Twice-grown (7 crops)	0·0–0·4	0	1	—	0
	0·5–2	0	4	—	0
	2·1–8	1	1	—	0
	8·1–20	1	0	—	0
	21 –60	3	0	—	4
	61 –100	2	1	—	3
	NORTH OF THE WASH				
Certified (23 crops)	0·0–0·4	12	17	21	8
	0·5–2	10	5	2	11
	2·1–8	1	1	0	4
Once-grown (16 crops)	0·0–0·4	5	9	16	3
	0·5–2	5	5	0	4
	2·1–8	1	2	0	4
	8·1–20	3	0	0	3
	21 –60	2	0	0	2

Leaf Roll was by far the most important disease in the seed at the time of planting, thus confirming general field observations that there was little Leaf-Drop Streak in 1940. By August 1941, however, there was a considerable amount of Leaf-Drop Streak in the south. Table 1 distinguishes the crops grown north and south of the Wash and shows the number of crops derived from each kind of seed, and the disease category into which they were placed. The average of total severe virus diseases in the south in certified, once-grown and twice-grown stocks was 4, 15 and 54 % respectively; in the north in certified and once-grown stocks it was 1·3 and 8·5 %.

Sugar-Beet Virus Yellows. The disease was late in appearing. During September and October thirty-four crops were recorded in Berks, Hants, Herts and Lincs. No field was free from the disease, nine showed less than 2 % of the plants infected, sixteen 2–6 %, seven 6–20 % and two over 20 %.

Wheat Take-All and Whiteheads (*Ophiobolus graminis* Sacc.). Eighty crops were examined; of these sixty-five had no plants with Whiteheads, six had less than 5 % of the plants affected, two had 6–20 % and seven 20–60 %. Forty-five of the crops were on newly ploughed grassland; of these forty were free from the disease and only one had more than 5 % of the plants affected.

Wheat Eyespot (*Cercosporella herpotrichoides* Fron). The proportion of 189 wheat crops examined that showed lodging in conjunction with Eyespot increased strikingly towards the east of the country, and was much greater in fields where wheat had been grown frequently in the past. In Wales less than 4 % of the wheat fields were infected, in the West Midlands 25 %, in the East Midlands 60 % and in East Anglia 85 %. The distribution of infection and its correlation with lodging are shown in Table 2. The records were taken shortly before harvest.

Table 2

% of straws infected	0	1–20	21–70	71–100
No. of fields in category	76	53	38	22
% area of crops lodged	3	12	13	37

Apple Scab (*Venturia inaequalis* (Cooke) Wint.). Six observers co-operated and twenty-two reports were received from Berks, Cambs, Hants, Kent, Northants and Worcs. Cox's Orange Pippin, Worcester Pearmain and Bramley's Seedling were the chief varieties recorded. The Tehon scale (Tehon & Stout, 1930) was used throughout for leaf grading, but it proved laborious and is probably erratic where a relatively small sample (500) of leaves is taken.

Miscellaneous. Reports were also received for the following diseases, but in numbers too small to permit analysis: Black Leg (three) and Dry Rot (three) of potatoes, Loose Smut of wheat (sixteen) and Brown Rot of apple (five).

Modified methods for 1942

As was to be expected, the experience gained in 1941 paved the way for various improvements in the methods employed. The revised sampling methods, which were circulated for use in 1942, are given below, but they, too, are to be regarded merely as another stage towards the ultimate goal. The same diseases were chosen, but the methods were simplified and the number of disease categories reduced. The symbols to be adopted in recording all diseases are approximations to a percentage infection; for virus and cereal diseases this involves a percentage of affected plants and heads respectively, and for foliage diseases a percentage of affected leaf area. Only crops with more than 1 % of disease estimated in this manner need to be sampled, and rapid visual methods for determining the dividing line have been added.

Cereals. Wheat Loose Smut, and Take-All, Eyespot and Brown Foot-Rot as far as they have caused Whiteheads, can all be recorded from the same traverses through the field. Two traverses should be made taking ten samples on each traverse, working along the drills but side-stepping three paces after each sample. The sample should consist of two one-yard lengths of drill row, consecutive but in adjacent drills. When Whiteheads are found the plants should be pulled up to determine whether the stem bases or roots are blackened (Take-All), or whether the Whiteheads are due to Eyespot, *Fusarium*, or a combined attack; a closer search should also be made along the sample for plants killed before heading. The number of affected plants, together with the larger number of affected tillers or heads produced by them, should be recorded for each pathogen.

Category %	Limits
< 0·01	Less than 1 head in 50 square yards
< 1·0	Less than 2 heads in 1 square yard
> 1·0	More than 2 heads in 1 square yard

If more than 1 % is estimated counts should be made.

Smuts of all cereals can also be estimated by counts of suitable samples when the crops are in stook, taking 500–1000 ears as a minimum for each field.

Potato Blight. Ten samples should be taken at suitable distances in the general direction of each diagonal of the field. It is not possible to stipulate a definite number of plants for an individual sample because of variations in growth, but care should be taken to see that neither leaves that would normally be moribund, nor plants attacked by Black-Leg or Leaf-Drop Streak, are included.

Category %	Limits
0·0	Not seen on field
< 0·1	One or two spots usually visible from any position, or the same percentage might be given by a few developing foci
< 1·0	About ten spots per plant, or general light spotting
< 25	Nearly every leaflet with lesions, plants still retaining normal form; field may smell of blight
< 50	Half of leaf area destroyed by blight
< 75	Three-quarters of leaf area destroyed by blight
100	Leaves completely destroyed by blight

It is suggested that in each observer's area each year the progress of Blight should be recorded from the earliest stages on at least one crop of each of the varieties King Edward and Majestic in terms of the agreed scale of Blight grades. Once the epidemic has started in an area as many other crops as possible should be recorded.

Virus Diseases (sugar-beet Yellows, potato Leaf Roll, Severe Mosaic and Leaf-Drop Streak). Below 1 % can be estimated visually. When more than 1 % of disease is present counts should be made on random samples on each of two diagonal traverses of the field. Some observers prefer a sample of thirty plants (ten in each of three rows chosen consistently from the sampling position), others a sample of one hundred plants (fifty on either side of the drill up which the observer walks). At least five hundred plants should be recorded on each traverse of the area. Potato primary Leaf Roll

and Leaf-Drop Streak should be recorded separately from secondary Leaf Roll and Severe Mosaic.

Category %	Limits: sugar beet	Limits: potatoes
0	Not seen on field	Not seen on field
< 0·1	1 in 7 yards radius	1 in 12 yards radius
< 1·0	1 in 2 yards radius	1 in 4 yards radius

If more than 1 % is estimated counts to be made.

Apple Scab. The categories given apply to vigorous bush trees ten to fifteen years old which in July normally bear 10–15,000 leaves per tree, and they must be modified proportionately for trees of other, widely different sizes. Cox's Orange Pippin, Worcester Pearmain or Bramley's Seedling should be chosen wherever possible. At least twenty-five and preferably fifty trees of any one variety, evenly distributed through the plantation, should be graded visually by walking slowly around each tree. Individual tree grades should be recorded as well as the average, but if the first five trees all fall in or below category < 1·0 further individual grading is unnecessary. Trees too large to give a satisfactory single symbol can be graded and recorded separately from the four sides (N., S., E., W.). Sampling to be done preferably in July.

Category %*	Limits
0	No Scab seen
< 0·2	Up to 20 leaves scabbed. Very light infection
< 1·0	20–100 leaves scabbed. Light infection
< 5·0	100–500 scabbed leaves readily seen. Moderate infection
< 25·0	500–2500 scabbed leaves. Healthy foliage still easily predominant. Severe infection
> 25·0	Above 2500 leaves scabbed. Scabbed foliage apparently predominant, but may in fact be no more than 50 %. Very severe infection

* The severity on individual leaves will normally increase with the grades.

Descriptive notes about age, rootstock, grass or cultivated plantations, spray treatment, etc., are also required.

In addition to testing the above sampling methods, each collaborator is invited to make visual estimates on the same crops. By this means it should be possible to determine to what extent purely visual estimates are reliable. Finally, it is hoped that the occasion of the Society's 1942 Plant Pathology Field Meeting will afford an opportunity for comparing estimates made on the same crop by different observers.

REFERENCES

Bawden, F. C. (1941). Report of sub-committee on plant disease measurement in the field. *Trans. Brit. myc. Soc.* xxv, 218.

Horsfall, J. G. & Heuberger, J. W. (1942). Measuring magnitude of a defoliation disease of tomatoes. *Phytopathology*, xxxii, 226–32.

Tehon, L. R. & Stout, G. L. (1930). Epidemic diseases of fruit trees in Illinois 1922–1928. *Bull. Ill. Dep. Registr. & Educ., Div. Nat. Hist. Survey*, xvii, Art. 3, 415–502.

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AGARICS. NEW RECORDS AND OBSERVATIONS. II.

By A. A. PEARSON, F.L.S.

Most of the species referred to in the following notes are new records for the British Isles. Some are already in our books and are included only because I am able to add some further details to the descriptions:

Lepiota fusca-vinacea Möller & Lange, in Lange, *Flora Agaricina Danica* 1, 33, Pl. 13, fig. H (1935).

Pileus up to $4\frac{1}{2}$ cm., flat with shallow umbo, cuticle with concentric rings of dark adpressed squamules except at the disc, the surface between being purplish pink (pale vinaceous); margin smooth and regular sometimes stretching beyond the gills. *Gills* crowded, with a few small ones, thin, linear or somewhat ventricose, 3–4 mm. wide, free. *Stem* 5–6 cm. long, 5–8 mm. thick, firm, solid, purplish pink like the pileus, fibrillose above the white membraneous ring, densely tomentose below. *Flesh* of pileus and stem white with slight purplish tinge. No taste or smell. *Spores* white in mass, $4–4\frac{1}{2} \times 2–2\frac{1}{2}\mu$, smooth. *Cystidia* on gill edge club-shaped $25–35\mu$ long by $8–12\mu$ wide.

Habitat on ground in mixed woods. Found at Kinlet Park, Shropshire, by Miss Sheila Patrick during the foray held at Ludlow, September 1937.

Pholiota aurea Fr.

A fine group of this species in various stages of growth, some very large, appeared on the ground in a timber yard at Haslemere, during October 1938, and the opportunity was taken to add a few details to the descriptions in our books.

Pileus 4–25 cm., fleshy, convex then expanding and finally slightly depressed in centre with mat powdery surface at first, then like soft leather, dry and smooth, with here and there radiating grooves, Chamois colour of Ridgway, cuticle peeling to centre; margin incurved at first. *Gills* 12 mm. wide in large specimens, crowded, linear or arcuate, attenuated both ends, adnexed, adnate or subdecurrent edge often undulate, tawny ochraceous, of different lengths. *Stem* 10–27 cm. long, solid at first, thickened at base, up to 25 mm. diam. above ring, pale at first, then golden ferruginous covered with a white pruinose film. *Ring* peronate, sheathing most of the stem and splayed out above with an undulate margin; the outer part of sheath fluted with furrows deep above, shallow lower down, the ridges between being denticulate, covered with powdery granules above, smooth below, base with white tomentum. *Flesh* white in pileus and in upper part of stem, ochraceous buff in lower part, deeper in colour near surface. *Taste:* mild. *Smell:* nothing special noticed but said to be strong by some authors. *Basidia* four-spored $38–40 \times 8–9\mu$. *Spores* in mass Clay colour of Ridgway, subfusoid, often with a large guttule $9–12 \times 4\frac{1}{2}–5\mu$.

Cystidia on gills not present. Surface of pileus with cells of different forms and sizes, mostly club- or sack-shaped, often with one or several finger-like appendages.

Pholiota aurea has been well illustrated in recent years by P. Heinemann in *Bull. Soc. Myc. Fr.* LIII, Atlas LXXV (1937), and by Lange in *Flora Agaricina Danica*, III, Pl. 105 C, the latter preferring to go back to the earlier name *Pholiota Vahlii* (Schum.). It may be doubted if the *Agaricus aureus* as described by Fries is the same, but his epithet for this species has been well established since it was described by R. Maire in *Bull. Soc. Myc. Fr.* XXVII, 438 (1911), with the suggestion that the powdery general veil and smooth spores were features justifying a new genus *Phaeolepiota*. This, however, has not found general acceptance.

Cooke's illustrations of this species have given rise to some confusion. The variety *Herefordensis* Renny on Pl. 374 (347) is the typical *Pholiota aurea* but too bright in colour; 373 (345) is probably *P. spectabilis*; 375 (348), wrongly named *P. caperata*, is certainly *P. aurea*, but there is a misprint in the spore dimensions which are given as $2 \times 4\frac{1}{2}\mu$ presumably instead of $12 \times 4\frac{1}{2}\mu$.

Clitocybe hirneola Fr.

Pileus 1–2 cm. submembranaceous, convex or umbilicate, lead colour or grey with a satin pruinose hoary white covering, which may be washed away in wet weather when it becomes clay-coloured or tawny olive with smooth surface, margin incurved then straight or undulate, sometimes striate. *Gills* crowded or subdistant, rather broad, adnate or subdecurrent, arcuate, pale clay or greyish, edge smooth or fimbriate. *Stem* 2–3 cm., slender, grey or clay colour, paler above, covered with white scattered fibrils or polished, equal or thicker above, sometimes with white tomentum at base. *Flesh* clay colour. *Smell* slightly mealy or none. *Taste* none or somewhat rancid. *Basidia* two- to four-spored $20–25 \times 6–8\mu$ with long sterigmata about 4μ. *Spores* in mass pinkish clay (Avellaneous of Ridgway), hyaline or very faintly coloured under the microscope, broadly ovate, with indistinct lateral apiculus, smooth, $6–8 \times 4\frac{1}{2}–5\mu$ non-amyloid. *Cystidia* on gill edge cylindrical or bottle-shaped with blunt apex, thin walled, $40–50 \times 10–12\mu$. Cuticle of pileus made up of septate hyphae $3–6\mu$ diam.

Habitat: on bare soil among heather and bracken especially where heath fires have taken place, isolated or in troops. Ludshott Common, Hampshire, November 1939 and 1940. Hindhead, Surrey, November 1940.

This agaric, which was abundant in 1939, has appeared only sporadically since, but is probably fairly common in the late autumn. Its distinctive features are the leaden hoary surface of the cap and the coloured spores. It is apt to be overlooked, as most specimens are small, semi-globate or with only slightly depressed cap. The larger specimens are sometimes deeply umbilicate. In fact, *Clitocybe hirneola* is a very variable fungus which may be recorded under other names and in other genera. It is very near *Tricholoma caelatum* Fr. which is described in great detail by Maire in *Bull. Soc. Myc. Fr.* XL, 298, and has verrucose spores, but it may be that this is part of the variability of this species. The spores of the specimens above

described were smooth when examined under an oil immersion lens. Doubtless it is often recorded as *Clitocybe rivulosa* which also has a satiny surface but differs in its small white spores and absence of cystidia.

Collybia misera Fr. sensu Lange. 'Studies in the Agarics of Denmark. III', *Dansk Bot. Ark.* II, no. 7, 20 (1917); *Flora Agaricina Danica*, II, 16, Pl. 45, fig. A (1936).

Pileus 1–2 cm., plano-convex, papillate, greyish umber with paler margin, strongly striate to umbo, edge regular, smooth. *Gills* broadly ventricose, fairly crowded, adnate or almost free, pale grey or dirty white, edge smooth, many lengths. *Stem* slender, 2–4 cm. long, dark grey, polished, pruinose above. *Flesh* dark grey when moist. *Smell* faint, rather rancid. *Basidia* four-spored. *Spores* white in mass, non-amyloid, narrow elliptic, smooth, 6–7 × 3½ μ. *Cystidia* none. *Cuticle* of pileus made up of elongated hyphae of different diameters, some sack-shaped and very bright under the microscope.

Habitat: gathered at edge of mixed wood, Thursley, Surrey, 6 November 1940.

It is doubtful whether this agaric is the *Agaricus miser* of Fries which has been variously interpreted by different authors. It is well illustrated by Lange and can be recorded under the name he assigned to it, until the *Tetrophanae* section of *Collybia* has been more thoroughly worked out.

Mycena uracea Pearson.

To the original description, *Trans. Brit. mycol. Soc.* XXII, 32–3 (1938), should be added 'spores amyloid'. As in all species of *Mycena* with warted cystidia, the spores turn blue with iodine.

Since this species was recorded, R. Kühner's Monograph of the genus *Mycena* has been published, and he describes, under the name of *M. megaspora* Kauffman, an American species which may be identical with *M. uracea*. The habitat is different; *M. megaspora* is found on bare peaty soil, while *M. uracea* appears on burnt ground attached to the roots of heather.

R. Singer has also recorded a similar species under the name of *M. permixta* (Britz.) Sacc. in *Rev. de Mycol.* II, 233 (1937). The habitat is said to be among *Sphagnum*.

Until further observations are made, *Mycena uracea* can stand. It is a common species in the late autumn, and I have gathered it in various places always on land where the heather has been burnt.

Photographs of *Mycena megaspora* Kauffman have since been sent to me by Mr Alex. H. Smith, who considers that this species is distinct from *M. uracea*.

Mycena mirata (Peck) sensu Smith, 'Studies in the Genus Mycena. I', *Amer. J. Bot.* XXII, 866, Pl. 3 (1935). Peck, *Bull. Buffalo Soc. Nat. Sci.* I, 48 (1873). Schroeter, *Die Pilze Schlesiens*, as *Agaricus* (*Mycena*) *corticola* Pers. p. 630 (1889). R. Kühner, *Le Genre Mycena*, p. 282 (1938).

Pileus 2–10 mm., membranaceous, semi-globate or subumbonate, sometimes with a papilla, whitish, pale brown at the disk, slight olive tinge when dry, striate or sulcate to disc. *Gills* subdistant, fairly broad, ventricose,

adnexed or free, cream, edge white, smooth or minutely fimbriate. *Stem* filiform, smooth, polished, grey, paler above, slightly swollen below, base sometimes hairy. *Smell* none. *Basidia* four-spored. *Spores* amyloid, elliptic apiculate with granular contents 8–9 × 5½–6 μ. *Cystidia* closely packed on gill edge, globose or sack-shaped, set with brush-like ornamentation. *Cuticle* of pileus with hyphae which turn blue with iodine, some being faintly warted.

Habitat: on bark of living trees, often among moss.

The specimens described above were on bark of oak and agree with Kühner's description except that the basidia had four sterigmata instead of two, and the spore range was smaller, which would be expected if two-spored basidia were absent.

Mycena mirata has some resemblance to *M. hiemalis* and a similar habitat, so it has probably been passed over as a form of this common species. The latter, however, differs in having non-amyloid spores and cylindrical smooth cystidia. Nearly related species like *M. supina* Fr. and pale forms of *M. corticola* Fr. have warted cystidia, but both have globose spores.

Mycena fellea Lange, 'Studies in the Agarics of Denmark. I', *Dansk Bot. Ark.* I, no. 5, 26 (1914). *Flora Agaricina Danica*, II, 37, Pl. 50. ? *Mycena erubescens* Von Höhnel, *Fragm.* XV, in *Sitz. K. Akad. Wiss. Wien*, Math.-Nat. Kl. I, LXXII, 267 (1913).

Pileus 3–10 mm. conical or semi-globate, dull grey or brown, with pale pruinose margin, striate. *Gills* subdistant, white, linear or slightly ventricose adnexed, broadly emarginate, two lengths. *Stem* 2–4 cm. long, slender, equal, hyaline or subfuscous, smooth, tomentose at base, sometimes when young with a whitish juice. *Taste* very bitter, not at first but like quinine after a while. No smell. *Basidia* 30–35 × 7½–8 μ with two long sterigmata. *Spores* amyloid, broadly ovate apiculate or pyriform with granular contents, one- to two-guttulate, 9–12 × 6–8 μ, smooth. *Cystidia* ventricose lanceolate often bifurcate, sometimes having several prongs, contents granular, abundantly scattered on gill edge and face, protruding conspicuously, 40–70 × 9–12 μ.

Habitat: usually on mossy trunks of deciduous trees, but the specimens described above were gathered at Goodwood, Sussex, on the ground under *Quercus Ilex* among moss and chips of wood, 15 November 1939. Rare in Great Britain but common in France and rather rare in Denmark.

In *Le Genre Mycena*, pp. 230–5 R. Kühner describes this species under *Mycena erubescens* V. Höhn., but neither in my specimens nor in those gathered by Lange did there occur any exudation from the pileus when cut nor any reddish coloration. It may well be that the two species are identical, the erubescent form being met with in southern climates. For the present it is preferable to use Lange's specific epithet which indicates a character not mentioned by Von Höhnel in his brief diagnosis. Kühner's specimens had basidia with two, three or four sterigmata.

Among my old notes of unnamed species of *Mycena* I find a drawing and full details of the above, found 26 November 1918 at St George's Hill, Surrey.

Mycena bulbosa (Cejp) Kühner, *Le Genre Mycena*, p. 176 (1938). *Pseudomycena bulbosa* Cejp, *Revise Omphalia-Mycena*, p. 149 (1930).

Pileus 3–6 mm., membranaceous, semiglobate, obtuse or subpapillate, striate or sulcate, greyish brown at first, then paler, hygrophanous, smooth, with gelatinous separable cuticle. *Gills* crowded, ventricose, adnexed becoming free, white or pale grey, alternate gills very short. *Stem* 4–10 mm. long, filiform, often curved, white hyaline or greyish brown, pulverulent *sub lente* with a basal disk 1–1½ mm. which is convex, pubescent, white and striate-sulcate on upper surface. A brown sclerotium is sometimes present hidden in the leaves from which the fruit body arises. *Taste* mild. *Smell* none. *Basidia* with four sterigmata. *Spores* non-amyloid, elliptical, 8–10 × 3½–4½ μ. *Cystidia* on gill edge only, ventricose or club-shaped, often bifurcated with several prongs. *Cuticle* of pileus with globose or pyriform cells, surface minutely granulate.

Habitat: at the base of tufts of rushes or more rarely of sedges. Found in various places in Sussex, Norfolk and Epping Forest.

This *Mycena* is common inside the tufts of rushes near the leaf base. In this sheltered situation the minute fruit bodies can be seen when the rushes are spread out. I recorded it for Epping Forest some years ago, but have since felt some doubts whether it is really distinct from *M. stylobates* which it closely resembles except that its more gelatinous nature makes it difficult to study and there are no spines on the pileus. Both belong to the section *Institicia* which Kühner established for the species of *Mycena* having the pileus flesh distinct from that of the stem. In species of this section the hyphae of pileus and stem do not curve into each other, but are respectively horizontal and vertical, so that the pileus easily drops off the stem. But the spores of *M. bulbosa*, unlike all the other known species of this section, do not colour blue with iodine.

Mycena subalpina Von Höhnel, *Fragm.* xv, in *Sitz. K. Akad. Wiss. Wien*, Math.-Nat. Kl. I, cxxii, 21 (1913); Kühner, *Le Genre Mycena*, p. 543 (1938). *Collybia pseudo-radicata* Lange & Möller, *Friesia*, xv, 294 (1936); *Flora Agaricina Danica*, II, 13, Pl. 43, fig. A (1936).

Pileus conical or flat 1½–3 cm., membranaceous, dull brownish yellow or pale honey colour, mat, faintly striate or not at all, margin sometimes slightly exceeding gills. *Gills* subdistant, white, ventricose, rather broad, adnexed emarginate, edge rather shaggy, undulate. *Stem* 4–6 cm. long, 2½–3 mm. thick, somewhat cartilaginous, white, pruinose above, more or less striate, woolly at base. No smell or taste. *Basidia* with four sterigmata. *Spores* non-amyloid, white, cylindrical, slightly curved, 7½–10 × 2½–4 μ (mostly 8 × 3½ μ in my specimens). *Cystidia* on gill edge and face, flask-shaped with obtuse apex, smooth, 60–65 × 15 μ at base and 5–6½ above.

Habitat: solitary on sticks or chips in deciduous woods especially beech. In mixed wood Donhead St Mary, Wiltshire, 17 July 1939. Collected by A. Dunston, and recorded in *Wilts. Arch. and Nat. Hist. Mag.* xlix, 150 (1940).

Mycena subalpina is uncommon, but may have been passed over as a form of *M. galericulata* which it resembles in some respects. The microscopic

characters are quite different and the spores of the latter turn blue with iodine.

Cooke's illustration 198 (205) of *Collybia collina* probably represents the above species.

Omphalia rosella J. E. Lange, 'Studies in the Agarics of Denmark. VIII', *Dansk Bot. Ark.* VI, no. 5, 14 (1930); *Flora Agaricina Danica*, II, Pl. 60, fig. C (1936).

Pileus submembranaceous, 5–15 mm., pale buff or brownish pink, mat, somewhat furfuraceous, depressed or deeply infundibuliform, margin plicate, incurved at first. *Gills* pale pink, arcuate, narrow, subdistant, rather thick, deeply decurrent, edge concolorous or sometimes darker, mostly one length with a few short ones. *Stem* relatively stout, 1–2 cm. long, 1–2 mm. thick, white or slightly pink tinged, naked or with fine white fibrils, equal or slightly thickened at the base. No taste or smell. Whole plant fairly firm and elastic. *Basidia* four-spored. *Spores* white in mass, non-amyloid, elliptical, flattened on one side, apiculate, smooth, $7\frac{1}{2}$–9×4–$4\frac{1}{2}\mu$, one- to two-guttulate in dropped spores. *Cystidia* scattered on edge of gill, cylindrical, 4μ diam., in projecting part, thickened at base.

Habitat: in short grass. Hindhead, Surrey, 20–27 October 1941.

This attractive *Omphalia*, which may be common as it appeared in quantities on my tennis lawn, has doubtless been confused with *O. demissa* Fr., which has a more striking resemblance to *Laccaria laccata*, grows in woods and has larger spores and no cystidia. *Omphalia demissa*, however, is not so well defined as we should like. Lange's measurements of the spores are much the same as for his *O. rosella*. Some years ago I had some specimens and measured the spores as 10–12×6–7μ. Bresadola and also Cejp in his monograph of *Omphalia* give 10–12×6–8μ. On Culbin Sands, Moray Firth, Scotland, I gathered specimens of an agaric growing on sand looking remarkably like *Laccaria laccata* but with smooth guttulate spores measuring 16–18×6–8μ which may be a form of *Omphalia demissa* Fr.

Marasmius lupuletorum (Weinm.) Bresadola, *Fungi Trident.* II, 24, Pl. 130 (1892); *Ic. myc.* Pl. 495 (1929). *Agaricus dryophilus* var. *lupuletorum* Weinmann, *Hym. et Gasterom. Rossiae*, I, 76 (1836); Konrad & Maublanc, *Icon. selectae fungorum*, Pl. 218.

Pileus $1\frac{1}{2}$–$3\frac{1}{2}$ cm., convex then flat, subumbonate, light buff darker in centre, cuticle adnate, dry, smooth, glabrous, margin thin, striate or sulcate, regular or undulate. *Gills* distant, adnexed then free, deeply ventricose, light buff, sometimes interveined, of several lengths. *Stem* $1\frac{1}{2}$–8 cm. long, cartilaginous, attenuated below, bay brown, paler above, velvety pruinose, base strigose. *Flesh* in pileus whitish, in stem light buff, sometimes bay brown or darker below. *Spores* non-amyloid, elongate pip-shaped, 7–9×4–5μ. *Cystidia* absent on gills, present on stem in bunches, brown, fusiform 30–60×4–6μ.

Habitat: in frondose and coniferous woods. Found in Wiltshire by T. F. G. W. Dunston and A. E. A. Dunston, October 1938, and recorded in the *Wilts. Arch. and Nat. Hist. Mag.* XLVIII, 484.

An uncommon species which may have been confused with the more common agaric which is recorded either as *Marasmius erythropus* (Pers.) Fr. or *Collybia acervata* Fr. and which has a much brighter coloured stem and smaller spores.

Russula brunneo-violacea R. Crawshay, *Spore Ornamentation of the Russulas*, p. 90, Pl. IX (1930). *R. purpurea* Gill., Cooke's *Ill. of Br. Fungi*, Pl. 986 (1022), cited by Crawshay. *R. pseudo-violacea* Joachim, *Bull. Soc. Myc. Fr.* XLVII, 256, Pl. VIII.

Pileus 3–10 cm., semiglobate then plane or depressed, at first violet-black, later violet or violet-brown or violaceous purple, often very dark in centre, occasionally with patches of yellow or rusty colour; exceptionally the whole surface may be mottled with yellow and dusky violet; mat, viscid when wet, margin smooth, sometimes sulcate, blunt. *Gills* rounded near margin of pileus, attenuated towards stem, adnexed or free or subdecurrent, white then cream, crowded, brittle. *Stem* 3–5 cm. long, 8–12 mm. thick, equal or slightly enlarged at base, at first firm, finally soft; white, turning brown in patches when handled. *Flesh* white or faintly yellow under the cuticle which is easily peeled. *Taste* mild. *Smell* none. *Spores* in mass cream (B to D of Crawshay's chart) somewhat variable, subglobose with long spines when examined under high magnification, finely reticulate, mostly $8\frac{1}{2}$–$7\frac{1}{2}\mu$. J. Schaeffer in his Monograph gives $8–10 \times 7–9\mu$ and Crawshay, who gives an accurate drawing of the spores, describes them as follows: 'Average measurement $8\frac{1}{2} \times 9\frac{1}{2}\mu$. The surface is covered with conspicuous protuberances which are rather above the usual size; in a certain number of spores the protuberances are unconnected, but in the majority they are connected by extremely thin lines which form a reticulation over a large part of the surface. Many of these spores possess an unusually large apiculus.' *Cystidia* abundant on gill edge, sparse on face, turning blue with sulphovanillin.

Habitat: in deciduous woods. Crawshay and Schaeffer record only from oak woods; Joachim under beech. My specimens were growing under or near birch in Rothiemurchus Forest and Kingussie, Scotland, August 1939. Also found in mixed wood of oak and birch at Hindhead, Surrey, August 1941.

This species, which is normally very dark violet colour, may prove to be fairly common. It is more slender than *Russula atropurpurea* which has white spores, and other Russulas nearest in colour and build are acrid. *R. violacea* Quél. is stated by Rea to be common, but I have never seen it in Britain; the strong smell of laudanum is characteristic, as I was able to verify when it was gathered in France.

Lactarius helvus Fr. is not well known to British mycologists and perhaps Cooke's plate 955 (994), which in colour is not in the least like the agaric it represents, is partly to be blamed for this. I have often gathered it, and the following description is taken from specimens which were growing under pine trees in Broadwater Forest, East Sussex, August 1936. *Lactarius helvus* was very plentiful that year, but I have not seen it in quantities since.

Pileus 4–20 cm. diam., depressed in centre, more or less infundibuliform, often with acute papilla, margin incurved when young, sometimes undulate

when old, not striate, felty with minute squamules, light pinkish cinnamon or very milky coffee colour, not zoned. *Gills* crowded, linear attenuated at both ends, about 5 mm. wide, decurrent or subdecurrent, forked from base, thin, edge smooth, cinnamon buff, small gills near margin. *Stem* 3–6 cm. long, 1–1½ cm. thick, cylindrical, often attenuated at base, straight or curved, firm when young, brittle when old, solid then hollow, dry, minutely fibrillose almost smooth, rather more reddish than pileus, base white tomentose. *Flesh* pallid with faint cinnamon tinge. *Milk* colourless watery not issuing except when young, mild, or very slightly acrid. *Smell* hardly perceptible when fresh, but pungently aromatic when dry like *Lactarius camphoratus*. *Basidia* four-spored. *Spores* in mass pale cream colour, broadly ovate, outline coarsely warted, covered with fairly thick reticulation when seen under high magnification, 7–9 × 5½–6 μ. *Cystidia* on and near gill edge, cylindrical or slightly ventricose, blunt, not turning blue with sulphovanillin. No cystidia on pileus or stem. *Flesh* turns purple with Sv. and has no colour reaction from green vitriol or phenol.

Habitat: in moist coniferous woods.

Not considered a good edible, but *fide* Konrad and Favre, *Bull. Soc. Myc. Fr.* LI, 145 (1933), it is used when dry as a condiment in powder form.

L. helvus has been recorded in America as *L. aquifluus* Peck.

Cortinarius (Telamonia) malachius (Fr.), *Epicrisis*, p. 280 (1836); *Monographia*, 2nd ed., p. 361 (1874).

Pileus 4–15 cm., semi-globose at first, gibbous when expanded, fleshy, firm when young then soft; hoary ochraceous buff, then reddish buff often with reddish spots, tomentose *sub lente*; veil pale azure or lavender colour, then white adhering in small tufts or larger adnate patches near the margin; margin incurved at first and often when old, regular then undulate; cuticle dry, separable at margin sometimes to disk, radially cracking when old. *Gills* sub-crowded, broadly linear, pointed at margin, adnate with narrow emargination 6–10 mm. wide, not veined, edge more or less wavy, purplish blue before veil breaks, but when exposed to air instantly turning to purplish brown and finally to tawny brown. *Stem* cylindrical above, irregularly bulbous below, 10–14 cm. long, 1–2½ cm. thick, in large specimens with less bulbous base, firm when young, spongy when older, pale lavender-blue veil peronate below, often with adnate ring above and sometimes with other shaggy remains of veil which turns white with age and sometimes disappears leaving the stem naked. The base is often densely covered with a pale lavender-coloured tomentum, which is white when old. The bluish lavender tinge suffusing the stem is usually persistent but sometimes absent in old specimens. *Flesh* pale lavender-blue when young, then whitish and finally ochraceous buff. *Taste* mild. *Smell* not unpleasant. *Basidia* four-spored, with long sterigmata. *Spores* in mass light brown (Antique brown of Ridgway), surface smooth 7 × 4 μ. *Cystidia* none, but some large sack-shaped cells of different sizes were observed on the gill edge. *Veil* made up of hyaline septate hyphae 6–8 μ wide with occasional clamp connexions.

Habitat: in mixed woods. Our specimens were growing on sandy soil, under oaks, among bracken, near some young pine trees. Hindhead, early September 1941.

The above description taken from a number of specimens in all stages of growth, that appeared during a week, corresponds closely to that given by Fries in *Monographia.* Mr Carleton Rea, to whom specimens were sent, agrees. The spore measurements differ from those given by Quélet and by Lange, but I have no hesitation in determining our specimens as *Cortinarius malachius* Fr. Though the stem characters are clearly those of a *Telamonia,* it was placed by Fries in the *Inoloma* section on account of its hoary pileus. This character, however, is present in other species of the *Telamonia* group and its more correct position is next to *Cortinarius torvus* Fr. The bluish colour of the gills can be observed only when unexpanded specimens are freshly gathered, as the colour instantly changes when exposed to the air.

Cortinarius (Telamonia) helvelloides Fr.

As this species is not well known, though it sometimes appears in large troops in shady swampy places, a full description may be useful:

Pileus 1–4 cm. (mostly 2 cm.), fleshy in centre, membranaceous elsewhere, campanulate or conical at first, then flat or with shallow umbo, margin incurved and regular at first, finally upturned and undulate, dry, yellowish brown or dark ferruginous, brighter when dry with rusty gold centre, hoary with minute pale squamules, golden *sub lente* in a strong light. *Gills* distant, broadly linear, very variable in width, 3–7 mm., adnate with decurrent tooth, thick, dark violet at first, soon changing to dark brown, edge concolorous or paler, sometimes interveined in old specimens, in three lengths. *Stem* 4–8 cm. long, about 3 mm. thick, equal, firm, solid with an internal fibrous packing then hollow, rusty golden, reddish below, fibrillose with shaggy fragments of golden veil on the upper part of the stem forming a ring in young specimens, but usually absent. Base white strigose. *Flesh* brown in pileus, bright ferruginous in stem. No taste or smell. *Basidia* four-spored, 30–35 × 8–9 μ. *Spores* elliptic, apiculate, minutely punctate, $8\frac{1}{2}$–9 × 5–$5\frac{1}{4}$ μ. *Cystidia* absent. Elongated hairs 12–20 μ diam. on pileus. Hyphae with clamp connexions 8–10 μ wide on stem.

Fries in his description states that the gills are '*e violaceo—umbrino cinnameis*', but he placed this species in the group with gills yellow or cinnamon, not violet. Rea grouped it in the same section which made its determination difficult, but I am indebted to him for identifying specimens.

The above description was made from a large number of specimens gathered on 30 August 1936 which appeared for several years in a swamp under alders near Tunbridge Wells, Kent. Occasional specimens also grew on the edge of a ditch near Frant, Sussex.

The most prominent feature of *Cortinarius helvelloides* is the hoary squamulose pileus which shows up more distinctly when dry.

Alex. H. Smith has recorded this species from Michigan, U.S.A., under the name *C.* (*Dermocybe*) *lacorum* Smith in *Ann. Myc.* XXXII, 472 (1934).

I suspect that *C.* (*Inoloma*) *penicillatus* Fr. is the same species.

Cortinarius (Hydrocybe) rubricosus Fr. sensu Lange.

Pileus 5–7 cm., fleshy in centre, subconical at first, soon expanding, with prominent umbo usually blunt, sometimes acute, often depressed round umbo, reddish-brown, paler at margin. Veil faintly evident on margin which is regular at first, but soon gets shaggy. *Gills* ventricose or broadly linear, 7–10 mm. wide, distant, concolorous, adnate becoming free, edge smooth. *Stem* solid then hollow, 6–8 cm. long, 8–10 mm. thick, concolorous, striate with pallid fibrils, equal or slightly attenuated at the base which is covered with a white pubescence. *Flesh* of pileus and stem brown. No smell or taste. *Basidia* four-spored. *Spores* in mass reddish brown (Amber Brown of Ridgway), broadly ovate, pip-shaped, warted, $8–9 \times 5\frac{1}{2}–6\mu$. *Cystidia* absent.

Habitat: on ground under *Pinus silvestris*, Thursley, Surrey, 4 November 1940.

The false ring mentioned by Fries was not seen in the specimens gathered, and it is not certain that we are dealing with the true *rubricosus* of Fries. Our specimens were clearly the same as illustrated by Lange in his *Flora Agaricina Danica*, Pl. 100, fig. F, and his interpretation of this rare species can be adopted for the present. Much work remains to be done before we can identify the puzzling members of the *Hydrocybe* group of *Cortinarius* with any certainty, more especially the smaller species. *C. rubricosus*, however, is of good size and can be distinguished by its umbonate cap and uniform date-brown colour.

Inocybe halophila Heim, *Le Genre Inocybe*, p. 242 (1931).

Pileus $1\frac{1}{2}–3$ cm. diam., umbonate or semi-globate, dark brown, shaggy and covered wholly or in part with a white arachnoid veil, fleshy in centre, membranaceous elsewhere. *Gills* deeply ventricose, free, brown with darker edge, often growing beyond margin of pileus. *Stem* rather short, equal or slightly thickened at the base, dark brown or pinkish, striate with whitish or yellowish fugacious fibrils. *Flesh* green in the pileus and apex of stem, brown in stem but paler at base. *Taste* mild. *Smell* not specially noticeable. *Basidia* four-spored. *Spores* in mass snuff-brown, cylindrical, narrowed to an obtuse point at the apex, broadly blunt at the base, straight or somewhat oblique, smooth, $10–14 \times 5–6\mu$ with large oblong guttule (full range *sec.* Heim, $9{\cdot}5 \times 20 \times 5–8\mu$). *Cystidia* on gill edge globose or sack-shaped at first, then flask-shaped with either broad or narrow neck, sometimes crested with lime crystals, hyaline or brown of various dimensions up to $90 \times 16\mu$ ($45–65 \times 11\frac{1}{2}–27\mu$, *sec.* Heim).

Habitat: in sea sand. Abundant in one small area on Culbin Sands, Moray Firth, Scotland, 19 August 1939.

Except for a few minor details, my specimens agree with Dr Heim's description, to whom I sent specimens for confirmation. The main difference is the persistent arachnoid veil which gave the group a very striking appearance. Heim says that the veil is fugacious. Mr Carleton Rea thinks this may be the species gathered on Culbin Sands in 1912 on the occasion of the B.M.S. foray, and named by him *Inocybe abjecta* Kant., which both

Lange and Heim identify with *I. flocculosa* Berk. It is doubtful, however, whether our species is really distinct from *I. lacera* Fr., one of our commonest species and very variable. The spore, which is so distinctive in this species, agrees exactly, but the macroscopic features are so unusual that there is some justification for separating the two species until we have some proof that *I. halophila* is merely a form due to its habitat in sea sand.

Astrosporina umboninota (Peck) n.comb. *Inocybe umboninota* Peck, *N.Y. State Mus.* CXXXIX, 58 (1910). *Inocybe acuta* Boud., *Bull. Soc. Mvc. Fr.* XXXIII, 8, Pl. 1, fig. 2 (1917).

Pileus 1–4 cm., convex with a sharp prominent umbo, chestnut brown, darker in centre, umbo sometimes black, margin pale, radially fibrillose, more or less rimose, umbo smooth, margin incurved at first. *Gills* crowded, ventricose, pale then snuff colour, adnexed or free, sometimes minutely emarginate, edge delicately flocculose *sub lente*. *Stem* 2–5 cm. long, 2·3 mm. thick, solid, straight or curved, chestnut below, pale and pulverulent above, striate with fibrils, non-emarginate bulb at base not always well defined and white at first, then brown. *Flesh* white in pileus and stem at first, turning pale brown. No taste or smell. *Basidia* four-spored. *Spores* in mass snuff brown, nodulose 8–9 × 5½–6½ μ, profile irregularly elliptical or subtriangular with nodules fairly prominent obtuse or acute. *Cystidia* on gill edge and face ventricose, neck not much narrowed, apex blunt, crested with crystals, hyaline, 50–70 × 15–20 μ.

Habitat: on the ground in boggy places, usually solitary. On bank of ditch in pine wood, Blackmoor, Hampshire, August 1937, and many other places since.

The species of *Astrosporina* with acute umbo run into each other rather closely. The above is nearly related to *A. napipes* (Lange) and is distinguished in the field by its short and slender stature.

Astrosporina Boltonii (Heim) n.comb. *Inocybe Boltonii* Heim, *Le Genre Inocybe*, p. 345 bis (1931). *Inocybe Rickenii* Heim non Kallenbach, *Le Genre Inocybe*, p. 346, Pl. XXXII.

Pileus 2½–5 cm., campanulate, gibbous or umbonate, rusty tawny then dark brown with adpressed radial fibrils, the disc often densely packed with short flat squamules. *Gills* crowded, fairly broad, ventricose, broadly adnate, edge smooth, pale at first then ferruginous brown. *Stem* 4–6 cm. long, 3½–5½ mm. thick, equal, striate with adpressed fibrils and some shaggy loose ones, pale brown or rusty below, pale and pruinose above, base white, solid then hollow. *Flesh* white or rusty brown in both pileus and stem. *Smell* none or slightly mealy. *Taste* mild. *Basidia* four-spored. *Spores* in mass snuff brown, irregularly angular with obtuse angles and prominent apical acute point; flattened below with no apiculus, 8–12 × 5–7 μ. *Cystidia* on gill edge and face, ventricose, obtuse, crested with crystals, thick walled at summit, hyaline, 30–55 × 18–21 μ. (Measurements of cystidia are those of Dr Heim, but specimens kindly identified by him had larger cystidia.)

Habitat: on sandy ground, solitary or in small groups, Epping Forest,

October 1935, sent by Mr R. E. B. Brinton. Also Henley, Sussex, November 1938.

In *Bull. Soc. Myc. Fr.* XLVIII, 147 (1932), Kühner has expressed some doubt whether *Inocybe Boltonii* Heim is distinct from *I. decipientiodes* Peck (=*globocystis* Vel.). They would seem to run into each other and their spores are very similar. In their typical forms, however, they are very distinct, and for the present it seems desirable to have a name by which we can identify an agaric which makes its appearance from time to time.

Galera Mairei (Kühner) n.comb. *Conocybe Mairei* Kühner, *Le Genre Galera*, p. 131 (1935).

Pileus 4–9 mm., convex or subconical, striate or sulcate at the margin, hygrophanous, light ochraceous buff, pulverulent with a greyish pruinous glistening *sub lente*. *Gills* concolorous then deeper in colour, thick, ventricose, subdistant, broadly adnate, sometimes exuding water-drops from edge. *Stem* short, equal or subbulbous, pale ochre above, darker below, delicately pulverulent below, hollow. *Basidia* four-spored. *Spores* elliptical, apiculate, smooth, $6\frac{1}{2}$–$7\frac{1}{2} \times 4$–$4\frac{1}{2}\mu$. *Cystidia* on gill edge abundant, 20–30μ long, thin walled, swollen below and narrowing to a long slender beak about 2μ wide. The cuticle of the pileus is made up of globose or balloon-shaped cells mixed with long beaked cystidia from which (see Kühner) exudes the moisture which produces the pruinose surface; similar cystidia occur on the stem.

Habitat: solitary or in groups in grassy places. Hindhead, 29 September 1938 near beech and holly.

This small *Galera* has the aspect of a small *Naucoria escharoides* but with strikingly granular pileus and ventricose gills.

The species of *Galera* with the cuticle of the pileus consisting of globose or hymeniform cells have been placed in a separate genus (*Conocybe* Fayod emend.) by Kühner, and those with elongated hyphae into another genus (*Galerina* Earle emend.). Although I do not follow Kühner in withdrawing such species from the genus *Galera*, I think the two segregates will prove useful as sectional headings in the grouping of *Galera* species.

Galera graminea Velenovský, *České Houby*, p. 548 (1921). *Galerina graminea* (Vel.) Kühner, *Le Genre Galera*, p. 168 (1935).

Pileus 5–10 mm., membranaceous, campanulate or shallowly conical, then flat with small umbo, finally upturned, hygrophanous, light ochraceous, margin pale and centre dark, finally whitish buff and sometimes furfuraceous, striate only when fresh. *Gills* subdistant of several lengths, thin, ventricose, adnate emarginate with decurrent tooth, but sometimes adnexed almost free with no decurrence, often veined near and on lower surface of pileus, light honey colour at first then ochraceous, edge smooth. *Stem* 2–$2\frac{1}{2}$ cm. long, about 1 mm. thick, pale honey colour covered with silky white striate fibrils, straight or flexuose, equal or slightly swollen at the base. No taste or smell. *Flesh* pale honey colour. *Basidia* mostly four-spored. *Spores* in mass ochraceous brown (Antique Brown of Ridgway), minutely punctate or smooth, 7–8 × 4–5μ (full range 7–11 × 4–$5\frac{1}{2}$), ellip-

tical or more or less obovate. *Cystidia* scattered on gill edge and sometimes on face, 20–40 μ long, bulbous below with a long slender neck, globose or oval at apex. *Cuticle* of pileus made up of elongated hyphae, 3–7 μ diam.

Habitat: on ground among moss. It appeared in large quantities scattered over my tennis lawn at Hindhead, Surrey, during October 1941, especially in the mossy places.

Galera nana (Petri) n.comb. *Naucoria nana* Petri, *N. Giorn. bot. it.* x, 357 (1903); *Ann. mycol.* II, 9 (1904). *Inocybe Whitei* Vel. non Berk. Br., *České Houby*, p. 371 (1920). *Galerula Velenovsky* Kühner, *Bull. Soc. Myc. Fr.* L, 72 (1934). *Galerina nana* (Petri) Kühner, *Le Genre Galera*, p. 219 (1935).

Pileus 4–25 mm., membranaceous, hygrophanous, slightly viscid, glabrous, fragile, conical or convex, umbonate or flat, sometimes papillate, striate, ochraceous brown with darker centre, pale when dry, margin regular or sometimes crenulate. *Gills* distant, thin, ochraceous, broad, ventricose or subtriangular, adnate or subdecurrent, emarginate. *Stem* 2–6 cm. long, equal, straight or flexuose, ochraceous, darker towards base, delicately pruinose above with adpressed fibrils below. *Flesh* ochraceous. *Taste* mild. *Smell* mealy, scarcely perceptible. *Basidia* with two sterigmata (sometimes three, see Kühner). *Spores* in mass brown (Brussels Brown of Ridgway), almond-shaped or subfusiform, surface with a shallow mottled ornamentation. *Cystidia* abundant and prominently projecting on gill edge and face, flask-shaped, thick walled with crested apex, staining sulphur yellow with ammonia and vinaceous purple with cresyl blue. *Cuticle* of pileus consisting of elongated hyphae $2\frac{1}{2}$–$3\frac{1}{2}$ μ diam.

Habitat: grassy places or naked soil. The typical small form I gathered in Ashdown Forest, Sussex, 17 October 1931, and Dallington, Sussex, 30 September 1934. A large form (pileus 1–$2\frac{1}{2}$ cm.) with a densely caespitose habit was growing luxuriantly on an old sawdust heap at Plaistow, Sussex, 15 November 1938.

This not uncommon agaric has probably been identified with *Naucoria badipes* Fr. It is chiefly characterized by the cystidia which are of the type associated with the genus *Inocybe*. There is, however, a difference; the *Inocybe* cystidia turn blue with cresyl blue, while those of *Galera nana* turn a vinaceous purple as pointed out by Kühner. This species was described by Velenovský under the name *Inocybe Whitei* Berk. & Br., but Cooke's Illustration, Pl. 444 (404), representing this last species is certainly quite different.

With regard to *Naucoria badipes* Fr., this epithet has been used for several different species, and it would be well to accept the definition of Ricken who assigns the species to *Galera* rather than to *Naucoria*, which is at present a convenient dumping ground for many small brown-spored agarics which have still to find their right taxonomic position. *G. badipes* (? Fr.) Ricken is very like *G. nana*; it has two-spored basidia, and spores of the same shape, but differs in the cystidia which are thin walled and without the crested apex. It is not uncommon in grassy places on the edge of woods.

Psathyra pennata Fr. forma ***annulata*** n.f.

Pileus 1–3 cm., membranaceous, convex or conical, then expanding with persistent blunt umbo, edge incurved, finally upturned but sometimes the margin remains involute, ochraceous, umbo darker, wrinkled in old specimens, at first covered with white fugacious scales. *Gills* subdistant, broad, ventricose, adnate, white at first then fuscous brown, edge smooth. *Stem* 3–4 cm., white, tomentose above the ring, delicately fibrillose below, ochraceous flesh seen underneath the fibrils, equal or thickened at the base, fairly firm in outer coat with a fibrous core; veil forming a well-defined white woolly ring half-way up the stem, fairly persistent. *Flesh* ochraceous, dark line between pileus and gills. No smell or taste. *Spores* in mass Blackish Brown of Ridgway, subcylindrical, flattened on one side, more or less pointed at one end, dark brown under microscope, $6\frac{1}{2}$–7×3–$3\frac{1}{2}\mu$. *Cystidia* on gill edge fusoid with acute apex, 35–45×10–12μ.

Habitat: in troops on burnt soil near pine stump, Hindhead, Surrey, October 1941.

This small agaric was growing in abundance within the space of a few yards, while in other parts of the same ground were troops of the normal form of *Psathyra pennata* or what we call by this name, as it is the common species that flourishes on burnt soil. It is, however, doubtful if it is the same as recorded elsewhere. The British species invariably has small subcylindrical spores about $7 \times 3\mu$, but continental mycologists give the following measurements: Bresadola 8–9×4–$4\frac{1}{2}$, Ricken 8–9×5–6, Lange 8–$9\frac{1}{2} \times 4\frac{1}{2}\mu$.

The ringed form of *P. pennata* may have been recorded as a *Stropharia*, but no species in this genus seems to correspond.

Cooke's Plate 620 (580) of *Psathyra pennata* is fairly good except that unusually large specimens have been figured, and the patches of the white veil which are often very conspicuous in separate but very fugacious squamules near the margin of the pileus, are not shown; but this is a very variable feature.

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GLOEOSPORIUM PESTIFERUM, A SYNONYM OF *ELSINOE AMPELINA*

By ANNA E. JENKINS, *Bureau of Plant Industry, Washington, D.C.*

(With Plate IV)

Gloeosporium pestiferum Cke. & Mass. (1890) is based upon specimens of infected 'twigs, peduncles, and fruit of *Vitis vinifera*' from 'Brisbane (F. M. Bailey 881)'. Cooke (1890) noted that this organism was 'very destructive to vines'. Writing of it in the *Gardeners' Chronicle* (1891) he stated: 'In some respects the fungus resembles another of the same genus (*Gloeosporium ampelophagum*) common on vines in Europe and the United States; but it differs in the colour of the exuded spore masses, and the dimensions of the spores, which are double the length, and broader than in the European species; besides which we have no knowledge that the mass of spores in *Gloeosporium ampelophagum* ooze out and form such *Tubercularia*-like masses.' The note closes with the statement that the organism 'is an unenviable addition to the fungi of Australia'. *Gloeosporium ampelophagum* (Pass.) Sacc. is, of course, the grape anthracnose organism, which was earlier described as *Sphaceloma ampelinum* de By., and which is now known in its perfect stage as *Elsinoe ampelina* (de By.) Shear (1929).

Through Mr J. H. Simmonds of the Department of Agriculture and Stock, Brisbane, Queensland, with whom I have been in correspondence, the previously noted specimen, F. M. Bailey 881, in the Herbarium of the Government Botanist, Brisbane, was lent for examination by Mr C. T. White, Government Botanist.

The specimen, according to the label, is from grapes grown at Rockhampton, Queensland. It consists of a single shoot about 2 in. long, together with a few leaf fragments. The cankers on the heavily infected stem are typical of grape anthracnose. Sections through one of them showed abundant acervuli of *Elsinoe ampelina*. There was also seen a single biguttulate conidium, $6 \times 4 \mu$, evidently of this fungus. This conidial stage is probably the imperfect fungus that Cooke described as *Gloeosporium pestiferum*. The unusually large spores that he described apparently were swollen, as illustrated by Cobb (1903, fig. 111, compare with fig. 112) in a fungus now known to be related to the grape anthracnose organism, i.e. *Sphaceloma rosarum* (Pass.) Jenkins (1931). *G. pestiferum* as described by Cooke agrees in general with his illustration of *G. ampelophagum* (1893, fig. 10) and with such illustrations as those of earlier date by Scribner (1886, col. pl. 6 *a*, *b*). An illustration showing clearly the structure of the acervulus of *G. ampelophagum* was published in New South Wales by Cobb (1892, fig. 16). That author reproduced (1891 *b*) Cooke's second account (1891) on *G. pestiferum*, but made no comment on the identity of the fungus. He had written on grape anthracnose in New South Wales in 1891 (1891 *a*).

In Shear's collection at Washington, D.C., there is a fragment of the original type of Bailey's specimen 881 from Cooke's herbarium at Kew. This consists of parts of stems and a few berries. A second specimen from the Cooke Herbarium, shown to me by Dr Shear, bears the label '*Gloeosporium pestiferum* Cke. & Mass. Melbourne 574'. On the label of this specimen Dr Shear has indicated that the original label on the specimen at Kew is in Cooke's own handwriting. Concerning the two specimens Shear has also noted that 'these show undoubted anthracnose'.

It seems to be fully established, then, that *Gloeosporium pestiferum* Cke. & Mass. is a synonym of *Elsinoe ampelina*. D. Saccardo (1898) identified a fungus on grape in Italy as *Gloeosporium pestiferum* Cke. & Mass., but he explained certain lack of agreement. Judging from his description and illustration (pl. 8, fig. 8) of the Italian fungus, this is entirely different. Melbourne 514 may have been Cooke's (1892) basis for the distribution of *G. pestiferum* in Victoria. There are no specimens of *G. pestiferum*, so named, in the National Herbarium at Melbourne, as has been ascertained through Mr S. Fish, Biologist of the Victorian Department of Agriculture. He wrote (December) that there is one undated specimen of *G. pestiferum* in the herbarium of the Department of Agriculture labelled in the handwriting of D. McAlpine, with the details 'On *Vitis vinifera*, leaf and twig, Queensland, contributor, Bailey (and Kiel?)'.

Mr Fish stated also that the earliest specimen of *Gloeosporium ampelophagum* in the Herbarium of the Victoria Department of Agriculture is on vine leaves from Western Australia, 21 November 1898, contributed by R. Helms, while the earliest Victorian specimen is from Linton, 9 February 1903, T. M. Wise. Cooke (1892) reported *G. ampelophagum* from Victoria in 1892, but gave no other distribution.

The first diagnosis as well as the earliest account of grape anthracnose in Australia appears to be that by Tryon (1889) or Cobb (1891*a*, 1892). Excerpts from the first paragraph of Tryon's report are made as follows:

'The vine disease known throughout Australia as Black Spot, was observed to be prevalent at Toowoomba at the time of our visit....Black spot as a disease of the vine, was known in Australia as far back as 1862, if not at an earlier date, although we are not aware that its precise nature has ever been ascertained....Those Toowoomba settlers who have made their early acquaintance with the vines in the Rhine Districts designate this disease as the *Schwarze Brenner*, a malady of the vines known to be caused by *Sphaceloma ampelinum*, and microscopic examination establishes the fact that this title which they have bestowed is the correct one, and that the Black Spot and Schwarze Brenner are one and the same disease, both being due to the presence of the above-mentioned fungus.'

REFERENCES

Cobb, N. A. (1891*a*). Anthracnose or 'Black spot' on grape vines. *Agric. Gaz. N.S.W.* II, 60–1.

Cobb, N. A. (1891*b*). Notes on diseases of Plants. *Agric. Gaz. N.S.W.* II, 348.

Cobb, N. A. (1892). Diseases of the vine. Anthracnose or 'Black spot' (*Gloeosporium ampelophagum* Sacc.). *Agric. Gaz. N.S.W.* III, 291–2.

Cobb, N. A. (1903). Diseases of the rose. Black Spot. *Agric. Gaz. N.S.W.* XIV, 1063–4.

Cooke, M. C. (1890). Australian fungi. *Grevillea*, XIX, 61.

Cooke, M. C. (1891). Another vine disease (*Gloeosporium pestiferum* C. & M.). *Gdnrs' Chron.* 17 Jan. pp. 82–3.

Cooke, M. C. (1892). *Handbook of Australian Fungi*, p. 363.

Cooke, M. C. (1893). Anthracnose of the vine. *Gdnrs' Chron.* 8 July, p. 33.

Jenkins, A. E. (1931). Rose anthracnose caused by *Sphaceloma*. *J. agric. Res.* XLV, 330.

Saccardo, D. (1898). Contribuzione alla micologia veneta e modenese. *Malpighia*, XII, 216–17.

Scribner, F. L. (1886). Report on the fungus diseases of the grape vine. *Bull. U.S. Div. Bot.* II, 34–8.

Shear, C. L. (1929). Life history of *Sphaceloma ampelinum* de By. *Phytopathology*, XIX, 677.

Tryon, H. (1889). Report on insect and fungus pests. *Rep. Qd Dep. Agric.* I, 165–8.

EXPLANATION OF PLATE IV

Gloeosporium pestiferum Cke. & Mass. on grape vines from Rockhampton, Queensland, Bailey 881. A, the entire specimen, natural size. B and C, lesions from A, enlarged 10 times. C, *a*, lesion shown in A, *a*; B, lesion shown in A, *b*. D, label of specimen in original handwriting.

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A

B

C

Gloeosporium
pestiferum, Ckeet Mass
on grapevines Rockhampton

D

BRITISH NECTRIOIDEAE AND ALLIED GENERA

By T. PETCH

The formidable assemblage, Sphaeropsideae, which included fungi which looked like Sphaeriaceae but had their spores on sporophores instead of in asci, was divided by Saccardo into four groups, the first two being Sphaerioideae and Nectrioideae, the former having, as a rule, black or fuliginous, sometimes carbonaceous pycnidia like the perithecia of a *Sphaeria*, and the latter brightly coloured, soft or fleshy pycnidia like the perithecia of a *Nectria*. Roughly that corresponds to the division of the ascigerous forms into Sphaeriaceae and Hypocreaceae, and many of the Nectrioideae are stages of species of Hypocreaceae. The third volume of Saccardo's *Sylloge Fungorum* was based on that division and the system has now been in use for over fifty years, during which period numerous defects in Saccardo's arrangement, principally due to insufficient description on the part of the authors of the various genera and species, have become evident. The present account deals with the brightly coloured forms, Saccardo's Nectrioideae and part of his Excipulaceae.

Many of these pycnidial forms had been known for a long time as stages of Hypocreaceae, Discomycetes, etc., but in general it had not been considered necessary to give them separate names. Fuckel, for example, mentioned several, sometimes with a brief description. Saccardo bestowed names on these, and endeavoured to place them in their correct position relative to other pycnidial forms which had been named and described without association with any perfect form.

In the current century attempts have been made, particularly by von Höhnel, to correlate these forms and arrange them in a definite system, but, although von Höhnel examined type specimens whenever possible, much remains to be done before a satisfactory arrangement can be made. The original descriptions are often too brief to be of much service, and naturally they include only details which appeared to the describer to be of importance, whereas the systematist engaged in the classification of a number of forms may be compelled to adopt distinguishing characters, e.g. the position of the fungus in the host tissue, which the original describer did not consider worthy of record.

von Höhnel's chief communications are contained in the following articles and journals:

A. Zur Systematik der Sphaeropsideen und Melanconieen (Vorläufige Mitteilung), in *Annales Mycologici*, IX, 258–65 (1911).

B. System der Fungi Imperfecti, in Falck, *Mykologische Untersuchungen*, I, 301–69 (1923).

C. Fragmente zur Mykologie, nos. 1–1225, in *Sitzungsberichte der Akademie der Wissenschaften in Wien, Mathem.-naturw. Klasse*, Abt. I (1902–23).

D. Mykologisches, nos. 1–393 (24 parts), in *Österreichischen botanischen Zeitschrift* (1904–16).
E. Mykologische Fragmente, nos. 1–333 (14 parts), in *Annales Mycologici* (1903–20).
F. Fungi Imperfecti: Beiträge zur Kenntnis derselben, nos. 1–116 (3 parts), in *Hedwigia* (1917–20).
G. Vorläufige Mitteilung mykologischer Ergebnisse, 1–500 (5 parts), in *Berichte der Deutschen Botanischen Gesellschaft* (1917–19).
H. *Mitteilungen aus dem Botanischen Laboratorium* [later *Institut*] *der Technischen Hochschule in Wien*, I–XII (1924–35), published by Prof. Dr Josef Weese after von Höhnel's death.

These papers will be cited in the following pages by the letter prefixed to them. In 1911 (A) von Höhnel proposed the following division:

I. Pycnidiaceae.
  (*a*) Sphaerioideae.
    (α) Ostiolatae.
    (β) Astomae.
  (*b*) Nectrioideae.
    (α) Ostiolatae.
    (β) Astomae.
II. Patelloidaceae [later Patelloideae].
  (*a*) Excipulatae.
  (*b*) Patellatae.
III. Pycnothyriaceae.
IV. Stromaceae.

This account deals with the Nectrioideae-ostiolatae, Nectrioideae-astomae, and Patelloideae-patellatae, together with three genera of Stromaceae. The keys given are adapted from von Höhnel's key in his *System der Fungi Imperfecti*, abridged to include the small number of genera known to occur in this country.

von Höhnel's *System der Fungi Imperfecti* was published in 1923, but it had been sent to the editor in 1916, and publication had been delayed by war conditions. It would seem doubtful, therefore, whether the position of a genus in his *System* always represents his latest opinion, and it must be checked by reference to his later writings. The publication of these continued until his death in 1920, and notes which he left were afterwards published by Weese (H). Many of his later writings are merely preliminary lists of generic changes, and a formal description of the new genus does not appear always to have been published. Whether the new generic name is valid is a question for the nomenclatorial experts. In some instances, e.g. *Hyalopycnis*, the type of the genus is known, and the generic characters are given piecemeal in his key, but I have not found a formal description.

There would appear to be need for further investigation of several species included by von Höhnel in his pycnidial fungi to ascertain whether they actually have a pycnidium at any stage. *Ypsilonia cuspidata*, for example, placed by von Höhnel in Patelloideae-excipulatae, has a sporodochium surrounded by clusters of long setae which converge over it, but they are not united to one another above, and the fungus appears to be a hyphomycete. To illustrate the uncertainty which exists in some instances, *Microcera* may be cited. To some mycologists the sheath of *Microcera* is negligible, and the fungus is a *Fusarium*; to von Höhnel, the sheath constitutes a pycnidial wall, and the fungus belongs to the Patelloideae-

patellatae (G. no. 496, 1919; C. no. 1195, 1920). Actually the sheath divides above into laciniae and separate hyphae, and the fungus should be left in the Tuberculariae.

NECTRIOIDEAE

Pycnidia hyaline or light-coloured, membranous to fleshy, soft.

NECTRIOIDEAE-OSTIOLATAE

Pycnidia generally with a pre-indicated ostiolum.

I. Sporidia hyaline, oval, one-celled
  A. Pycnidia beaked or cylindrical, superficial
    (*a*) Sporidia with a cilium at each end — *Sphaeronaema* Fr.
    (*b*) Sporidia without cilia
      1. Pycnidia hyaline, of parallel broad hyphae: sporidia oval — *Hyalopycnis* v. Höhn.
      2. Pycnidia pyriform; sporidia small fusoid, acute — *Mycorhynchella* v. Höhn.
  B. Pycnidia not beaked
    (*a*) Immersed, becoming free — *Zythia* Fr.
    (*b*) Immersed, on an immersed stroma — *Zythiostroma* v. Höhn.
    (*c*) Superficial, blue or violet, parenchymatous — *Cyanophomella* v. Höhn.
    (*d*) Superficial, microplectenchymatous — *Pycnidiella* v. Höhn.

II. Sporidia oval, two-celled, hyaline or subhyaline
  A. Pycnidia superficial, light-coloured, not blue or violet — *Stylonectria* v. Höhn.

III. Sporidia hyaline, with several cross-septa
  A. Pycnidia superficial, blue or violet, large-celled parenchymatous — *Stagonostroma* Died. *Fusidomus* Grove

IV. Sporidia linear-fusoid, two-celled; pycnidia beaked, superficial — *Mycorhynchus* Sacc.

SPHAERONAEMA Fr. *Syst. Myc.* II, 535 (1823)

Type species, *Sphaeronaema subulatum* (Tode) Fr. *loc. cit.*

Pycnidia superficial, light-coloured, conoid, or flask-shaped, or subglobose with a short cylindrical or conical neck, wall membranous, parenchymatous, ostiolum fimbriate; sporophores stout, branched, sporidia apical and lateral; sporidia hyaline, continuous, oval, with a short pedicel and an apical seta.

Sphaeronaema subulatum (Tode) Fr. *Syst. Myc.* II, 535 (1823); *Sphaeria subulata* Tode, *Fung. Mecklenb. Sel.* II, 44 (1791); *Sphaeronaema oxysporum* Berk. *Lond. J. Bot.* (1847), 325; *Sphaeronaemella oxyspora* (Berk.) Sacc. *Syll. Fung.* III, 618 (1884).

Pycnidia scattered or clustered, conoid, rounded at the base, up to 0·6 mm. high, 0·4 mm. diameter, or flask-shaped or subglobose with a

short conical or subcylindrical neck, hyaline, wall parenchymatous, ostiolum fimbriate; sporophores stout, 2–3 μ diameter at the base, closely septate, with numerous lateral branches attenuated at their apices; sporidia terminal, or lateral at the septa of the main stem, hyaline, continuous, oval or narrow oval, 5–9 × 1·5–2·5 μ, with a pedicel 2–4 μ long, and an apical seta 3–7 μ long.

On decaying agarics, *Boletus*, *Sparassis*. Edinburgh and Tarbet (Greville); Appin (Carmichael); Cambridge (Berkeley); Thirsk (*Fungus Flora Yorks.*); Llanymawddwy (A. L. Smith); Westwick, Norfolk (Petch).

Fuckel (*Symb. Myc.* p. 183) claimed to have found asci in specimens of *S. subulatum*, and founded a new pyrenomycetous genus, *Eleutheromyces*. His claim has been supported by numerous mycologists and rejected by others (see Petch, *J. Bot.* (1935) p. 186), but, even if correct, *Sphaeronaema subulatum* still remains the name of the pycnidial form. As no other similar fungus has been described, *Sphaeronaema* is, up to the present, a monotypic genus.

In *Sylloge Fungorum*, Saccardo omitted *Sphaeronaema subulatum* from the genus, and drew up a generic description which, while retaining the general shape of the pycnidia, described them as superficial or immersed, membranous, coriaceous, or carbonaceous. Consequently the genus has come to include species of *Micropera*, over-ripe *Ceratostoma*, long-necked *Phoma*, etc. His type species is *Sphaeronaema polymorphum* Auersw. *Bot. Zeit.* p. 181 (1851), which, *teste* von Höhnel in F. No. 34 (1917), is *Glutinium laevatum* (Fr.) Stärb., the type of Fries's genus *Glutinium*. For other species of *Sphaeronaema*, see von Höhnel, *loc. cit.*

Of the species of *Sphaeronaema* enumerated by Grove in *British Stem and Leaf Fungi*:

S. spurium Sacc. is *Micropera spuria* v. Höhn. C. No. 950 (1916).

S. versiforme Fr. is *Micropera versiformis* Grove, II, 361.

S. rostratum Fuckel is *Ceratophoma rostrata* (Fuckel) v. Höhn. F. No. 34 (1917).

S. floccosum Grove and *S. mirabile* Grove are probably *Ceratophoma*.

S. epimyces (Ehrenb.) Berk. is 'certainly not a *Sphaeronaema*' (Grove).

S. deformans Berk.; *Phyllosticta deformans* (Berk.) Jacz., 'might be *Phyllosticta*' (Grove).

S. Lycopersici Plowr. Grove places this in *Ascochyta* (I, 314), probably correctly. Plowright described and figured the spores as continuous, but, *teste* Grove, the spores of *A. Lycopersici* may remain in that condition for a long time.

S. aemulans B. & Br. The type requires redescription.

S. glomeratum Mont. No such species. Saccardo suggested that this was an error for *S. fasciculatum* Mont. & Fr.

S. cornutum Preuss. As redescribed by Grove, and figured by Miss M. E. M. Johnston in *Trans. Brit. myc. Soc.* v, pl. VI, this is not a *Sphaeronaema*.

HYALOPYCNIS von Höhn. D. no. 162 (1916), name only

Type species, *Hyalopycnis vitrea* (Corda) v. Höhn. D. no. 162 (1916) and F. no. 58 (1918).

Pycnidia superficial, light-coloured, membranous, globose with a long subcylindrical beak, fimbriate at the apex; wall of venter and beak composed of parallel hyphae fused laterally; sporophores long, simple or branched; sporidia hyaline, continuous, cylindrical or oval.

Hyalopycnis blepharistoma (Berk.) v. Höhn. D. no. 162 (1916); *Sphaeronaema blepharistoma* Berk. *Mag. Zool. Bot.* I, 512 (1837); *Sphaeronaemella blepharistoma* (Berk.) Petch, *J. Bot.* p. 190 (1936).

Pycnidia superficial, globose, up to 0·3 mm. diameter, with a cylindrical beak up to 0·8 mm. high, 0·12 mm. diameter, fimbriate at the apex, hyaline; sporophores long; sporidia apical, hyaline, continuous, cylindrical with rounded ends, or oblong-oval, or oval, 8–13 × 3–5 μ, sometimes broadly apiculate.

On decaying *Russula adusta*, King's Cliffe (Berkeley); on the same host, North Wootton, May 1935.

Berkeley also recorded this species on nettle roots, and I have similar specimens on decaying stalks of *Brassica* and hollyhocks, but the latter have larger spores and are probably another species of *Hyalopycnis*. Berkeley's specimens on nettle, if any, have not been examined.

MYCORHYNCHELLA von Höhn. F. no. 59 (1918)

Type species, *Mycorhynchella exilis* v. Höhn. F. no. 59 (1918).

Pycnidia superficial, hyaline or bright-coloured, ovate, beaked, the venter small-celled plectenchymatous below, above (including the beak) of elongated parallel cells; sporophores simple; sporidia small, hyaline, cylindrico-fusoid, continuous, or longer and then septate.

Mycorhynchella glomerata (Grove) Petch, comb.nov.; *Sphaeronaemella glomerata* Grove, *Brit. Stem and Leaf Fungi*, II, 116 (1937).

Pycnidia solitary, or in clusters of three to six, superficial, soft, ovoid with a beak-like ostiole, i.e. obpyriform, 200–300μ diameter, pure rose-coloured, then rosy brownish, surrounded at the base by numerous delicate rosy intertwined hyphae; ostiolum fimbriate; sporidia very numerous, oval, obtuse, often somewhat curved, biguttulate, nearly colourless, 3–5 × 1·5μ.

On a gelatine culture in a Petri dish, Birmingham (Grove).

ZYTHIA Fr. *Summa Veg. Scand.* p. 407 (1849)

Type species, *Zythia elegans* Fr. *Summa Veg. Scand.* p. 408 (1849).

Pycnidia immersed, becoming free, globose, with a more or less evident papilla; wall of small cells, waxy-fleshy, light-coloured, usually yellow, orange, or red; sporophores various; sporidia hyaline, continuous, linear, ovoid, or oblong. See von Höhnel, C. nos. 26 (1902) and 906 (1915).

Zythia Mercurialis Kickx, *Flor. Crypt. Fland.* I, 449 (1867).

Pycnidia scattered or gregarious, dull yellow, then rust-coloured, finally brown and blackening, minute, almost globose, 100–125μ diameter, with an ostiolum 25μ diameter; sporidia ovate, usually about 5 × 2–2·5μ, with a few almost double in length, occasionally one-septate and constricted at the septum, 10 × 3μ.

On leaves, petioles, and stalks of *Mercurialis perennis*, Garforth, Yorks. (*Trans. Brit. myc. Soc.* VI, 79, 155); Lancashire (Grove).

The descriptions do not give any clue to the position of the pycnidia in the tissues, and specimens are not available at present. It is possible that this species is not *Zythia, sensu* von Höhnel.

Zythia leucoconia (B. & Br.) Sacc. *Syll. Fung.* III, 615; *Sphaeronaema leucoconium* B. & Br. *Ann. Nat. Hist.* (2), V, 371 (1850).

Pycnidia gregarious on a white subiculum, minute, depressed, sub-hemispherical or irregular, with a few hyphae spreading from the sides, hyaline, pale brownish in old herbarium specimens, pierced by a round pore, without a papilliform or elongated ostiolum, texture minutely parenchymatous; sporidia hyaline, ellipsoid, obtuse at both ends or somewhat pointed below, 5–6 × 2–3μ (Berkeley and Broome, and Grove).

On decaying roots of 'Silesian Beet', King's Cliffe (Berkeley), [? Sicilian Beet, *Beta Cicla*, Sugar Beet].

von Höhnel (C. No. 27) suggested that this species should be placed in *Libertiella* Speg. & Roum., which differs from *Zythia* only in the wider opening and consequent saucer shape of the pycnidia. The type requires redescription.

ZYTHIOSTROMA von Höhn. H. VIII, 89 (1931), emend.

Type species, *Zythiostroma Mougeotii* (Fr.) v. Höhn. H, VIII, 89 (1931).

Pycnidia subglobose, light-coloured, fleshy, soft, with a short cylindrical ostiolum, seated on a light-coloured fleshy stroma, but at first remaining immersed in the host; sporidia oval or oblong-oval, hyaline, continuous.

ZYTHIOSTROMA MOUGEOTII (Fr.) v. Höhn.; *Sphaeria Mougeotii* Fr. *Elenchus*, II, 100 (1828); *Sphaeronaemella Mougeotii* (Fr.) Sacc. *Syll. Fung.* III, 617 (1884).

Pycnidia subcortical, ostiolum erumpent, or exposed by abscission of the outer layers of the cortex, scattered, on an immersed, red, fleshy stroma, red, soft, subtranslucent, subglobose or conoid, 0·25–0·4 mm. diameter, ostiolum shortly cylindrical, dark red; sporophores fasciculate, short, simple or branched, the ultimate branches stout, conoid or somewhat flask-shaped; sporidia oblong-oval, hyaline, 2·5–3·5 × 1 μ.

The pycnidial stage of *Nectria sinopica* Fr. On dead stems of ivy, with the perithecial stage. North Wootton, October 1937, etc.; Mulgrave Woods, Yorks., October 1937 (W. G. Bramley).

The stroma and pycnidia may be exposed in cracks in the cortex, or may remain embedded, only the ostiola penetrating the cortex. When old, the outer layer of the cortex scales off, and the pycnidia may then be superficial, solitary or in small groups, on the inner tissues of the cortex. von Höhnel stated that the pycnidia were almost free, and placed *Zythiostroma* in his Stromaceae, but in my specimens the pycnidia appear to be quite superficial on the stroma, and in old specimens the stroma is lacking.

CYANOPHOMELLA von Höhn. F. No. 60 (1918)

Type species, *Cyanophomella acervalis* (Sacc.) v. Höhn. F. No. 60 (1918).

Pycnidia globose with a flat ostiolum, superficial, seated singly or caespitose on an erumpent, more or less evident stroma; wall fleshy to membranous, large-celled parenchymatous, more or less blue or violet; conidiophores simple; conidia small, hyaline, rod-shaped.

CYANOPHOMELLA ACERVALIS (Sacc.) v. Höhn. F. No. 60 (1918); *Phoma acervalis* Sacc. *Syll. Fung.* III, 97 (1884); Fuckel, *Symb. Myc.* p. 166 (1869).

Pycnidia caespitose, minute, fuscous; conidia very small, cylindrical, oscillating.

On dry branches of *Salix Caprea*, Rhenogovia.

This species was recorded by Fuckel as the spermogonium of *Gibberella acervalis*, and was subsequently named by Saccardo, the description cited being Fuckel's. It has not been recorded in this country, but *Gibberella acervalis* has.

PYCNIDIELLA von Höhn. C. No. 906 (1915)

Type species, *Pycnidiella resinae* (Ehrenb.) v. Höhn. C. No. 906 (1915).

Pycnidia superficial, fleshy, ostiolate; wall thick, soft, obscurely plectenchymatous-fibrous; internally lined everywhere with simple or fasciculately branched sporophores; sporidia hyaline, small, globose or ellipsoid, one-celled. Pycnidial stages of discomycetes.

PYCNIDIELLA RESINAE (Ehrenb.) v. Höhn. C. No. 906 (1915); *Cytospora resinae* Ehrenberg, *Silv. Ber.* p. 28 (1818); *Sphaeria resinae* Fr. *Syst. Myc.* II,

453 (1823); *Tuberculariа resinae* Thuem. *F. Austr.* No. 79; *Zythia resinae* (Ehrenb.) Karst. *Symb. Myc. Fenn.* XXI, 104 (1888).

Pycnidia gregarious or scattered, 0·2–0·3 mm. diameter, superficial, ovoid or sphaeroid, smooth, sordid red or orange red, ostiolate; wall 30–40 μ thick, densely plectenchymatous-fibrous without evident cellular structure; sporidia globose, hyaline, 1·5–2 μ diameter.

On resin of *Pinus sylvestris* and *P. austriaca*. The pycnidial stage of *Biatorella resinae* Mudd. The pycnidial stage has not been recorded for this country, though the perfect stage was recorded by Mudd, A. L. Smith, and Massee.

STYLONECTRIA von Höhn. C. No. 878 (1915)

Type species, *Stylonectria applanata* v. Höhn. C. No. 878 (1915).

Pycnidia superficial, with or without a stroma, like *Nectria* perithecia, but containing one-septate sporidia borne singly on short simple sporophores.

STYLONECTRIA APPLANATA v. Höhn. C. No. 878 (1915). Pycnidia scattered or gregarious, globose or oval, about 0·1 mm. diameter, with a flat apical disc which projects slightly over the body of the pycnidium, bright red becoming blood red; sporidia oval or oblong-oval, smooth, hyaline, one-septate, 9–12 × 4–4·5 μ.

The pycnidial stage of *Dialonectria applanata* (Fuckel) Petch; with the perithecial stage or separately, on effete pyrenomycetes. Guiting Wood, May 1938, on *Diaporthe decedens* on hazel.

STAGONOSTROMA Diedicke and *FUSIDOMUS* Grove

Pycnidia superficial, scattered or clustered, with or without a stroma, appearing black, but the wall blue or violet by transmitted light; wall parenchymatous, soft, large-celled; sporidia hyaline, oblong or fusiform, curved or straight, multiseptate; sporophores branched in *Fusidomus*, unknown in *Stagonostroma*. Pycnidial stages of *Gibberella*.

In *Notices of British Fungi*, No. 413* (1850), Berkeley and Broome described *Hendersonia arcus*, said to resemble in form and colour *Gibberella pulicaris*, with which it often grew. Its sporophores were described as branched, and its sporidia as elongated, curved, three-septate, swollen in the centre, attenuated to either extremity, hyaline. The type specimen grew on box twigs. No spore measurements were given.

Fuckel, in *Symbolae Mycologicae* (1869), enumerated pycnidial stages for several species of *Gibberella*, among them being '? macrostylospores', 26 × 6 μ, for *G. pulicaris*, found in immature perithecia, oblongo-fusiform, curved, three-septate, constricted at the septa, generally germinating; 'stylospores' in astomate pycnidia, oblong, one- to four-septate, sometimes constricted, 20–24 × 6 μ, for *G. Evonymi*; and '? macrostylospores', oblongo-fusiform, curved, three-septate, constricted, 26 × 6 μ, sometimes germinating, for *G. Saubinetii*. The last record is correctly entered in *Rabh. Krypt. Flora* under *G. cyanogena*, where it is stated that these stylospores occur in the young perithecia, and are similar to the ascospores, but smaller, narrower and more pointed, facts not given by Fuckel and probably incorrect.

In 1914, Diedicke (*Krypt.-Fl. Mark Brandenburg*, IX, 561 (1914)) established a new genus, *Stagonostroma*, with the species, *S. Dulcamarae* (Pass.) Died., evidently a pycnidial stage of a *Gibberella*. Grove stated that Diedicke described the spores as 'on inconspicuous pedicels', but Diedicke's phrase is 'sporenträger undeutlich'.

In 1919, von Höhnel, after examining the type specimen of Sydow's new genus, *Botryogene*, declared that it was an immature *Gibberella*, and that *Botryogene* = *Stagonostroma*. Of interest in the present discussion is that *Botryogene* was said to have sporidia on cylindrical pedicels, 15–30 μ long, each bearing one to four spores at the apex. von Höhnel transferred to *Stagonostroma*, *Hendersonia arcus* B. & Br. and *Stagonospora Euonymi* Sacc., the latter being Fuckel's stylospores on *Euonymus*.

In 1929, Grove (*J. Bot.* LXVII, 201–3) instituted a new genus, *Fusidomus*. His type is apparently *Fusidomus arcus* Grove, the only species described, but although this was described as '*sp.nov.*', it is evident from his later writings that he regarded it as the same as *Hendersonia arcus* B. & Br. Subsequently, his attention was directed to the work of Diedicke and von Höhnel, and in another paper (*J. Bot.* LXXII, 269–71 (1934)), he stated 'it is clear that this fungus of Diedicke's cannot be quite the same as *Fusidomus*, since the latter has its spores on conspicuous and persistent pedicels of a special character'. But, just as von Höhnel had dumped all these forms in *Stagonostroma*, so Grove, in the second volume of his *Stem and Leaf Fungi* (1937), placed them all in *Fusidomus*, including *Stagonostroma Dulcamarae* (Pass.) Died., the type of Diedicke's genus, *Stagonostroma*. That is clearly inadmissible, and if Grove's view is correct the name *Fusidomus* must be discarded.

There appear to be three kinds of spore phenomena in *Gibberella* which require elucidation. Perhaps the commonest is the occurrence, free in a perithecium, of rather large spores with rounded ends, like ascospores, usually in a state of germination. Multiseptate spores may also occur on short pedicels in immature perithecia, arising from hyaline tissue at the base of the perithecium; I have seen that only once, in an immature specimen of *G. pulicaris*, the spores being fusoid, equilateral and straight. Finally, there are the *Fusarium* conidiophores and the *Fusarium* spores described by Berkeley and Broome for *Hendersonia arcus*, and the foundation of Grove's *Fusidomus*; I have never met with a pycnidium containing these.

Fusidomus might be retained for the last named, but is it really needed? Grove wrote 'The explanation of these occurrences seems to be that the mycelium which ordinarily produces the *Fusarium* spores is here growing and producing them within a peridium that under other circumstances would have borne only asci and ascospores'. That appears to mean that *Fusidomus* is more or less an accident, and as the *Fusarium* has a name, at least sometimes, another name seems superfluous.

It is tempting to assume that Diedicke's *Stagonostroma* is Fuckel's stylosporic pycnidium. But the evidence is quite insufficient to support that conclusion. Unless a re-examination of the type throws more light on the origin of the spores the problem appears to be insoluble.

It might be thought a simple matter to examine these forms by modern methods and determine the mode of origin of the spores. Actually that is not so. These so-called pycnidia apparently occur at random among the perithecia, and there does not appear to be any way of identifying them beforehand. Nor, in my experience, can a specimen be definitely labelled as pycnidial. I have examined specimens assigned to *Fusidomus* by Grove, without finding anything resembling it. That does not imply that the labelling was incorrect, but probably that the original examination removed the *Fusidomus* pycnidia.

In a specimen of *Gibberella cyanogena* on *Brassica* stalks, gathered on 7 October 1941, the first perithecium examined had disorganized contents containing loose spores. Some of the spores were greatly constricted at the septa, and others were breaking up into separate cells, while many of them were in an advanced stage of germination. Some were adherent in clusters of four. Five other perithecia contained normal asci and ascospores, while a sixth had normal asci, but a few spores swelling and breaking up in the ascus.

An examination was then made of the perithecia situated on one stroma. Seven of these had normal contents, except for an occasional ascus containing spores breaking up into parts. One contained germinating spores with no clear evidence of their origin. The ninth (it was actually the first to be examined) contained immature asci with granular contents and no indication of spores, normal asci and ascospores, and ascus masses, i.e. the contents of an ascus, with eight or four spores adherent in a group the shape of an ascus, but without an evident ascus wall. Many of the spores in a mass had broken up into separate segments, which were rounded off, oblong-oval, globose, or, if terminal, ovate. Many of the spores were germinating while still in the ascus mass, and those in an early stage of germination left no room for doubt that the hyphae were germ tubes, not conidiophores.

I have found loose germinating spores in perithecia of *Gibberella* on several occasions, but the above was the first time I had been able to trace their origin from the asci. It seems most probable that, in general, germinating 'stylospores' in *Gibberella* perithecia are ascospores. They differ in shape from the *Fusarium* spores.

Grove's species of *Fusidomus* cannot be reclassified on the existing information, but the following notes may be of service.

Fusidomus arcus (B. & Br.) Grove is probably a stage of *Gibberella pulicaris*. Grove's figure agrees with the conidiophore of *Fusarium sambucinum*. It is to be noted that the

figure of the mature spores in his book is not quite the same as that in the *Journal of Botany*.

Fusidomus pulicaris Grove refers to the macrostylospores, and is not *Fusidomus*.

Fusidomus Euonymi Grove. I was unable to find pycnidia or perithecia on the Norfolk specimen cited by Grove. His description was taken from Fuckel, and refers to stylospores.

MYCORHYNCHUS Sacc. *Syll. Fung.* XVIII, 418 (1906)

Type species, *Mycorhynchus Marchalii* (Sacc. & March.) Migula, W., *Krypt.-Fl. Deutschland, Deutsch-Oesterreich und der Schweiz* (1921), p. 477.

Pycnidia subglobose below, with a long subulate beak, membranous, light-coloured; wall of the venter of large parenchymatous cells, those of the beak elongated, more or less parallel; sporidia hyaline, fusoid, acute, one-septate, sometimes shortly pedicellate.

Mycorhynchus Marchalii (Sacc. ex March.), Migula, W., *Krypt.-Fl. Deutschland, Deutsch-Oesterreich und der Schweiz* (1921), p. 477; *Rhynchomyces Marchalii* Sacc. in March. *Champ. Copr.* VI, 28 (1891).

Pycnidia superficial, gregarious, or clustered in subglobose tufts up to 0·5 mm. diameter on a delicate plectenchymatous pale brown stroma; pycnidia usually hyaline, venter flask-shaped, about 66μ high, 40μ diameter, passing into a long beak, up to 300μ high, 25μ diameter below; sporidia fusoid, attenuated below, sometimes into a thin appendage (pedicel), centrally one-septate, slightly curved, 40–63 × 6–7μ, with a mucous coat which swells up strongly in lactic acid. The sporidia are apparently attached by a short pedicel to the base of the pycnidium; on extrusion they frequently adhere in clusters of two or four.

On decaying stalks of *Brassica*, North Wootton, June 1935. On horsedung, Walton, Liverpool (Travis), *teste* Grove.

See Petch, *Ann. Myc.* XXXIV, 74, 75 (1936), for resemblance to *Treleasia Sacchari* Speg.; and *Trans. Brit. myc. Soc.* XXV, 173 (1941), for comparison with *Rhynchonectria longispora* (Phil. & Plowr.) v. Höhn.

Saccardo named Marchal's fungus *Rhynchomyces Marchalii*, and later, as that generic name was preoccupied, he substituted *Mycorhynchus*, but he omitted to 'make the combination', *Mycorhynchus Marchalii*.

In *Mitt. Tech. Hochs. Wien*, I, 60 (1924) Weese recorded that on the original specimen of *Nectria helminthicola* B. & Br., collected at Batheaston, January 1859, he found a pycnidial form with smooth, long-ellipsoid, thick-walled spores, 6–12 × 4–6μ, hyaline becoming brown, still one-celled, with an oil drop in the middle dividing the plasma in two. He suggested that when better material made complete observation on the final form of the sporophore and sporidia possible a new genus, *Styloletendraea*, might be established.

NECTRIOIDEAE-ASTOMAE

Pycnidia without an ostiolum, finally splitting irregularly and usually opening widely.

I. Sporidia oval, hyaline, one-celled	
(*a*) Sporophores mostly branched	*Pseudopatellina* v. Höhn.
(*b*) Sporophores absent	*Sclerozythia* Petch
II. Sporidia hyaline, two-celled, not catenulate	*Cystotricha* B. & Br.
III. Sporidia olivaceous, two-celled, pycnidia erumpent	*Pseudodiplodia* Karst.
IV. Sporidia long-cylindrical, two-celled; pycnidia globose, parenchymatous	*Trichocrea* March.

PSEUDOPATELLINA von Höhn. C. No. 179 (1908)

Type species, *Pseudopatellina conigena* (Niessl) v. Höhn. C. No. 179 (1908).

Pycnidia immersed, erumpent, soft, light-coloured, fleshy membranous, finally splitting above and then patellate; sporophores filling the whole interior, long, linear, branching and anastomosing [but see below]: sporidia continuous, apical on the sporophore.

Pseudopatellina conigena (Niessl) v. Höhn. C. No. 179 (1908); *Dacrymyces conigenus* Niessl in *Rabh. Fung. Europ.* No. 2628; *Dendrodochium album* Bayliss Elliott in *Trans. Brit. myc. Soc.* vi, 57, Pl. I, figs. 8–11 (1918).

Pycnidia various, circular, oval, or elongated, shallow, at first completely immersed, with a continuous, hyaline, small-celled plectenchymatous wall about 10μ thick, opening by the disintegration of upper wall and the overlying host-tissue, and becoming patellate, pale yellow, pallid when wet, surrounded by the upturned tissue of the host and pycnidial wall, base sometimes convoluted; conidiophores elongated conoid, about 12 × 1·5μ, completely lining the pycnidium, arising directly from the wall, or in small clusters at the apices of short hyphae, or laterally on long, flexuose, branching and anastomosing hyphae, about 1μ diameter, which run indefinitely through the pycnidium; sporidia apical on the sporophores, hyaline, continuous, oblong oval, 2 × 1μ, with a few globose, 1μ, persisting involved in mucus.

On fallen cones of *Pinus sylvestris*, Tanworth-in-Arden (Bayliss Elliott); North Wootton, Norfolk; Hubberholme, Yorks.

von Höhnel appears to have overlooked the stratum of sporophores on the pycnidial wall, while Mrs Bayliss Elliott did not record the long sporiferous hyphae described by von Höhnel; both may depend on the stage of development reached by the pycnidium, but they occurred together in my specimens. When the overlying tissue disintegrates, fragments consisting of single host cells, or small groups of host cells, with pieces of the pycnidial wall and sporophores attached, may remain in the mass of conidia; these recall the 'cells' described and figured by Corda as occurring in the spore masses of *Phymatostroma* and *Leucosporium*.

SCLEROZYTHIA Petch, in Grove, ii, 363 (1937)

Type species, *Sclerozythia Brassicae* Petch, in Grove, ii, 363 (1937).

Pycnidia superficial, bright coloured, astomate, solid, parenchymatous; sporidia hyaline, continuous, in parallel rows in the parenchyma; no conidiophores.

Sclerozythia Brassicae Petch, in Grove, ii, 363 (1937).

Pycnidia scattered or gregarious, superficial, ovoid or subglobose, up to 250μ diameter, dark amber, then dull red, glabrous, with a thick parenchymatous wall of large cells, up to 27 × 22μ, pale yellow becoming red, internally hyaline, parenchymatous, at first closed, then opening by a pore; sporidia oblong-oval, continuous, smooth, hyaline, 15–30 × 7–11μ, formed in short parallel lines in the parenchyma, not persisting in chains.

On decaying stems of *Brassica*, North Wootton, Norfolk, June 1935.

Zythia Brassicae Sacc. & Roum. appears to be a similar species, but the sporidia are different, according to the description.

In the description in Grove, ii, 118, 'dark amber' is printed 'dark umber', with a corresponding error in the Latin description, p. 363.

CYSTOTRICHA B. & Br. *Ann. Mag. Nat. Hist.* (2), v, 457 (1850)

Type species, *Cystotricha striola* B. & Br. *Ann. Mag. Nat. Hist.* (2), v, 457 (1850).

Pycnidia growing on wood, superficial or nearly so, horizontally elongated, opening by a longitudinal fissure. Sporophores branched, jointed, submoniliform, here and there beset laterally and terminally with oblong, hyaline, uniseptate sporidia.

Cystotricha striola B. & Br. *Ann. Mag. Nat. Hist.* (2), v, 457 (1850), Pl. 12, fig. 10; Grove, *British Stem and Leaf Fungi*, II, 145; *Pseudopatella Tulasnei* Sacc. *Syll. Fung.* III, 688 (1884); *Cystotricha compressa* (P.) v. Höhn. C. No. 538 (1910).

Pycnidia punctiform or linear, often arranged in short lines, appearing black with a reddish tinge, but the tissue brownish wine-red; disc reddish; soft-fleshy, the tissue small-celled plectenchymatous; spores oblong, acrogenous and pleurogenous, hyaline, continuous, then one-septate with the septum very delicate, $7–10 \times 3\mu$; sporophores long, cylindrical, once or twice branched above, septate from the base, submoniliform, the joints about as long as broad (Grove and von Höhnel).

On decorticated wood, Batheaston, Somerset; King's Cliffe, Elton, Northants; Wiltshire.

The pycnidial stage of *Durella compressa* Tul. (*Peziza compressa* Pers.), hence von Höhnel's name. Not recorded under *Durella compressa* by Phillips or Massee.

PSEUDODIPLODIA Karsten, *Symb. Myc. Fenn.* XV, 156 (as subgenus), Sacc. *Syll. Fung.* III, 621

Type species, *Pseudodiplodia ligniaria* Karst. *Symb. Myc. Fenn.* XV, 156 (1884).

Pycnidia more or less superficial, globose, waxy-fleshy, fuliginous when moist, soon opening with a wide mouth; sporidia ellipsoid, one-septate, pale olivaceous.

Pseudodiplodia corticis Grove, *J. Bot.* (1886), p. 197, Pl. 266, fig. 6.

Pycnidia gregarious, or collected in short lines or spots, globose or oblong, erumpent, then nearly superficial, when dry brownish-black, smooth, shining, 1–1·4 mm. diameter, pierced by a small pore which soon widens and exposes a disc; wall soft, waxy, olivaceous, subferruginous, minutely parenchymatous; sporophores somewhat branched, fasciculate, twice or thrice as long as the spore; sporidia oblong, subfusoid, obtuse at both ends, or pointed at one end, rarely somewhat curved, for a long time continuous, but finally delicately one-septate, hyaline singly, pale olive in mass, $10–14 \times 3–4\mu$ (Grove).

On the inner side of bark of sycamore, Sutton Coldfield.

TRICHOCREA Marchal, *Champ. Copr.* VI, 14 (1891)

Type species, *Trichocrea stenospora* March. *Champ. Copr.* VI, 14, (1891).

Pycnidia superficial, ovoid, light-coloured, rather soft and waxy, at first closed, then widely open and almost discoid, texture parenchymatous;

sporidia very numerous, narrow cylindrical, one-septate, hyaline; sporophores elongated, filiform, densely fasciculate, branched above.

Trichocrea oödes Bayliss Elliott, *Trans. Brit. myc. Soc.* VI, 58 (1918), Pl. I, figs. 12–16.

Pycnidia gregarious, superficial, ovate, stalked, 130–190 × 180–200 μ, with a stalk, 50–100 μ long, shining, whitish; texture of very narrow, interwoven, septate hyphae; at first closed, then open, margin fringed with converging hairs; sporidia linear, straight, some slightly bent and thicker in the middle, hyaline, pluriguttulate, not septate, 30–60 × 0·5 μ; sporophores branched, arising in dense fascicles from the base of the pycnidium.

On a fallen cone of *Pinus sylvestris*, Tanworth-in-Arden, Warwickshire.

As pointed out by Mrs Bayliss Elliott, it seems doubtful whether this species is correctly placed in *Trichocrea*, as the pycnidium is not parenchymatous and the sporidia have not been observed to be septate.

PATELLOIDEAE

Pycnidia becoming widely concave, with sporophores more or less confined to the base, thus forming a discoid hymenium.

PATELLOIDEAE-PATELLATAE

Pycnidia white or light-coloured, membranous to fleshy, soft.

I.	Sporidia hyaline, one-celled, not ciliate	
	A. Sporidia fusoid, curved; sporophores short	*Hainesia* Ell. & Sacc.
	B. Sporidia small, globose; sporophores long, branched	*Catinula* Lév.
II.	Sporidia hyaline, one-celled, ciliate at both ends	
	A. Sporidia ovoid	*Chaetospermum* Sacc.
	B. Sporidia cylindrical	*Ciliospora* Zimm.
III.	Sporidia hyaline, one-celled, catenulate	
	A. Receptacle sessile	*Patellina* Grove *non* Speg.
	B. Receptacle stalked	*Siroscyphella* v. Höhn.

HAINESIA Ellis & Sacc. *Syll. Fung.* III, 698 (1884)

Char. emend. von Höhnel, F. No. 67 (1918).

Type species, *Hainesia rhoina* Ellis & Sacc. *Syll. Fung.* III, 698 (1884).

Pycnidia immersed, then erumpent, patellate, widely and circularly open above, base small-celled parenchymatous; excipulum almost smooth externally, light-coloured, fleshy, composed of parallel hyphae; sporophores simple, or long fasciculately branched (as in *Tuberculariа*); sporidia terminal, and lateral on very short branches, hyaline, continuous, fusoid, curved.

Grove included this genus, with the species, *Hainesia Rubi* (Westend.) Sacc., which he suggested should be taken as the type. The type, however, is *Hainesia rhoina*, and *Hainesia Rubi* is not a *Hainesia*, but a member of the Tuberculariae, *Leptosporium Rubi* (Westend.) v. Höhn., *Leptosporium* Sacc. non Bonorden, *teste* von Höhnel, F. No. 67 (1918). There are no known British species of *Hainesia*.

CATINULA Lév. *Ann. Sci. nat.* IX, 247 (1848)

Type species, *Catinula aurea* Lév. *Ann. Sci. nat.* IX, 247 (1848).

Pycnidia superficial, at first closed, flat-discoid or pulvinate, then open and cup-shaped; sporophores long, branched; sporidia apical, globose.

CATINULA AUREA Lév. *Ann. Sci. nat.* IX, 247 (1848); *Lemalis aurea* (Lév.) Sacc. *Syll. Fung.* III, 672 (1884); Elliott and Stansfield, *Trans. Brit. myc. Soc.* VIII, 252, fig. 4 (1923); Grove, II, 131, fig. 61; *Dendrodochium citrinum* Grove, *J. Bot.* 1886, p. 18, Pl. 267, fig. 8.

Pycnidia superficial, at first closed, pulvinate, flattened, or globose, then cup-shaped or urceolate, sheathed below, often with a spreading rim, lemon yellow; receptacle parenchymatous below, composed towards the margin of parallel, thick-walled hyphae, 1·5–2 μ broad; sporophores parallel, long, fasciculately branched; sporidia apical, globose, hyaline or yellowish, 1·5–2 μ diameter, very numerous, united by mucus.

On cones and wood of *Pinus sylvestris*, Barnt Green, Warwickshire (Grove); Tanworth-in-Arden (Bayliss Elliott); North Wootton (Petch).

Saccardo, in *Syll. Fung.* III, 672, placed *Catinula aurea* in *Lemalis* Fr., but that is inadmissible as it is the type species of the genus *Catinula*, and, moreover, the type of *Lemalis* Fr. is a discomycete, *teste* von Höhn. C. No. 551 (1910).

Catinula turgida Desm., recorded in *Trans. Brit. myc. Soc.* XV, 3, is *Psilospora turgida* (Desm.) v. Höhn. C. No. 913 (1915), and belongs to von Höhnel's section Stromaceae.

CHAETOSPERMUM Sacc. *Syll. Fung.* X, 706 (1892)

Type species, *Chaetospermum chaetosporum* (Pat.) A. L. Smith & Ramsbottom, *Trans. Brit. myc. Soc.* IV, 328 (1914).

Pycnidia gelatinous; sporophore branched; sporidia ovoid, hyaline, with setae at each end.

CHAETOSPERMUM CHAETOSPORUM (Pat.) A. L. Smith & Ramsbottom, *Trans. Brit. myc. Soc.* IV, 328 (1914); von Höhn. H. I, 86 (1924); *Tubercularia chaetospora* Pat. *Bull. Soc. Myc. France*, IV, p. xl with fig. (1888); *Chaetospermum tubercularioides* Sacc. *Syll. Fung.* X, 706 (1892).

Pycnidia sessile, scattered or gregarious, 0·5–2 mm. broad, white, gelatinous, orbicular; sporophores hyaline, branched; sporidia ovoid, 38–43 × 8–10 μ, hyaline, copiously guttulate, furnished with seven to eight setae, equal in length to the sporidium.

On decaying leaves, in a wood near Rodborough Common, September 1913.

CILIOSPORA Zimm. *Zentr. f. Bakt.* Abt. 2, VIII, 217 (1902)

Type species, *Ciliospora gelatinosa* Zimm. *Zent. f. Bakt.* Abt. 2, VIII, 217 (1902).

Pycnidia superficial, gelatinous; sporidia continuous, hyaline, furnished with cilia at or near the ends.

CILIOSPORA ALBIDA (Massee & Crossl.) Grove, *British Stem and Leaf Fungi*, II, 117 (1937); *Dilophospora albida* Massee & Crossl. *Naturalist*, 1904, p. 3.

Pycnidia gregarious, rounded or elongated, up to 1 mm. long, whitish, gelatinous; sporophores short, erect, crowded, filiform; sporidia oblong-fusoid, obtusely rounded at the ends, hyaline, 28–40 × 6–8 μ, furnished at or near each end with up to five hyaline cilia.

On dead stems of *Epilobium hirsutum*, Hebden Bridge, Yorks.

It seems doubtful whether *Ciliospora* is distinct from *Chaetospermum*. The type of the former has long cylindrical spores.

PATELLINA Grove *non* Speg. *Brit. Stem and Leaf Fungi*, II, 131 (1937)

Type species, *Patellina caesia* Elliott & Stansf. *Trans. Brit. myc. Soc.* VIII, 250 (1923).

Excipula between cup-shaped and saucer-shaped, fleshy, glabrous (? always), sessile, bright coloured. Spores globose, ellipsoid, or cylindrical, unicellular, hyaline, growing in chains at the apex of long cylindrical hyphae (Grove).

PATELLINA CAESIA Elliott & Stansfield, *Trans. Brit. myc. Soc.* VIII, 250, Fig. 2 (1923); Grove, II, 132.

Receptacle patelliform, like the apothecium of a discomycete, grey, pubescent, about 1 mm. broad; sporidia cylindrical, hyaline, more or less obliquely truncate at both ends, about $10 \times 1{\cdot}5\mu$; sporophores fasciculate, branched, cylindrical, producing long chains of sporidia (Grove).

On cones of *Pinus sylvestris*, Tanworth-in-Arden.

PATELLINA DIAPHANA Elliott & Stansfield, *Trans. Brit. myc. Soc.* VIII, 251, Fig. 3 (1923).

Receptacle like that of *P. caesia*, but glabrous and entirely white; sporidia similar, but not in such long chains, $5–6{\cdot}5 \times 1–1{\cdot}5\mu$; sporophores long (Grove).

On dead roots of *Populus*, Tanworth-in-Arden.

Neither of these species agrees with the description of *Patellina* Speg., which was not described as having branched sporophores, or cylindrical sporidia, or sporidia in chains. Grove modified the generic description to fit them. But, *teste* von Höhn. in C. No. 908 (1915), *Patellina* Speg. is *Catinula* Lév. It is difficult to decide where these two fungi should be placed, as the details given are scarcely sufficient. Elliott and Stansfield described the receptacle of *P. caesia* as 'composed of pure white hairs arranged parallel to one another', and that of *P. diaphana* as 'composed of very narrow parallel hyphae'. The sporophores of *Sirocyphis* Clements were said to be simple, while *Siroscyphella* von Höhn. C. No. 549 (1910), which has branched sporophores and chains of cylindrical sporidia, was described as having a short, thick stalk. The type of the latter, *Siroscyphella succinea* (Fr.) v. Höhn. C. No. 1077 (1920), grew on needles of *Pinus*, and it was recorded under the name *Dacrymyces succineus* Fr. by Phillips and Plowright, who regarded it as a stage of their *Peziza electrina*, *Grev.* VIII, 155. Massee included it under Fries's name in *British Fung. Fl.* I, 67, and as a stage of *Orbilia succinea* Quél. in *British Fung. Fl.* IV, 495. *Patellina caesia* is probably *Siroscyphella succinea*.

As regards *P. diaphana*, the details given are somewhat contradictory, probably because its description is not independent, but partly a comparison with *P. caesia*. Elliott and Stansfield's Latin description says 'Conidiis similibus, non longe catenatis,...hyphis longioribus suffultis', and in their general account they state that the sporophores are branched, much longer than in *P. caesia*, and that the sporidia are lateral and do not cling together in chains. But Grove, probably translating the Latin description, gave 'spores similar, but not in such long chains'. If the sporidia are not catenulate, it is probably *Pseudozythia* v. Höhn.

There do not appear to be any type or authentic specimens of either of these species.

SIROSCYPHELLA von Höhn. C. No. 549 (1910)

Type species, *Siroscyphella succinea* (Fr.) v. Höhn. C. No. 1077 (1918).

Pycnidia superficial, glabrous, pezizoid, with a short, thick stalk, parenchymatous below; excipulum of parallel fibres, fleshy, light-coloured; sporophores crowded, fasciculately branched, with hyaline, cylindrical, continuous sporidia in chains.

Siroscyphella succinea (Fr.) v. Höhn. C. No. 1077 (1918); *Dacrymyces succineus* Fr. *Hymen. Europ.* p. 699 (1874); Phil. & Plowr. *Grevillea*, VIII, 155 (1880); *Dacryomyces succineus* Fr. in Massee, *Brit. Fung. Fl.* I, 67 (1892); *Siroscyphella fumosellina* (Stärb.) v. Höhn. C. No. 549 (1910).

Pezizoid; disc 200–300μ broad, with a short, thick stalk, 120 × 120μ; excipulum 20μ thick, composed of parallel, brownish hyphae, thick-walled, about 5μ broad, truncate at the obtuse margin; stalk and hypothecial tissue of thick-walled parenchyma cells, 4–5μ broad; hymenium of crowded, very thin, fasciculately branched sporophores, 40–50μ long; sporidia cylindrical, straight, truncate, hyaline, continuous, 12–14 × 1·5μ, in long apical chains. The fungus is seated on a thin basal layer which consists of brown, thin-walled, interwoven hyphae, resting on the epidermis of the host (von Höhnel).

On pine needles, Forres; recorded by Phillips and Plowright as a stage of *Peziza electrina* Phil. & Plowr. According to von Höhnel, it is the pycnidial stage of *Pocillum fumosellum* (C. & E.) v. Höhn.

STROMACEAE

No true pycnidia; sporidia contained in loculi in or on a stroma.

(As there are few recorded British hypocreaceous genera in this group, von Höhnel's key has been discarded.)

A. Stroma fleshy, light-coloured, immersed; loculi immersed in the stroma — *Polystigmina* Sacc.

B. Stroma immersed, light- or dark-coloured; loculi in erumpent processes, usually cartilaginous or coriaceous — *Micropera* Lév.

C. Stroma superficial, fleshy; loculi immersed; sporidia rod-shaped — *Dothiorina* v. Höhn.

POLYSTIGMINA Sacc. *Syll. Fung.* III, 622 (1884)

Type species, *Polystigmina rubra* (Desm.) Sacc. *Syll. Fung.* III, 622 (1884).

Stroma foliicolous, immersed, discoid, flattened-convex, somewhat fleshy, reddish, internally plurilocular; sporidia filiform, curved or hooked, continuous, hyaline.

Polystigmina rubra (Desm.) Sacc. *Syll. Fung.* III, 622 (1884); *Septoria rubra* Desm. *Ann. Sci. Nat.* XIX, 342 (1843).

Stromata hypophyllous, roundish, rather flat or convex, fleshy, reddish yellow; loculi small, numerous, immersed, ostiola punctiform, opening on the under side of the leaf; sporidia linear, at first straight, becoming curved or hooked and thicker below, 25–30 × 1–1·5μ.

On leaves of *Prunus spinosa*, *P. insititia*, and *P. domestica*.

The pycnidial stage of *Polystigma rubrum* DC. The ascigerous stage of the latter develops after the leaves have fallen; consequently, records of *Polystigma rubrum* usually refer to *Polystigmina rubra*. There should be a corresponding name for the pycnidial stage of *Polystigma fulvum* DC., but it does not appear to have been invented.

MICROPERA Lév. in *Ann. Sci. nat.* (3), V, 283 (1846)

Type species, *Micropera drupacearum* Lév. *Ann. Sci. nat.* (3), V, 283 (1846).

Stroma immersed; pycnidial processes erumpent, becoming almost super-

ficial, generally densely caespitose, globoso-conoid or columnar; wall leathery, or corky, or cartilaginous, light- or dark-coloured, but not really black, composed of thick-walled cells; ostiola spurious; sporophores short, lining the wall; sporidia filiform-fusoid, straight or curved, hyaline, multiguttulate. Pycnidial stages of discomycetes.

Micropera drupacearum Lév. *Ann. Sci. nat.* (3), v, 283 (1846).

Pycnidial processes leathery, immersed in the cortex, then erumpent, obovoid or subcylindrical, distorted by mutual pressure, red brown, appearing black, externally scurfy, orifice whitish; sporophores branched or fasciculate, subulate, up to 20μ long; sporidia narrowly cylindraceo-fusoid, curved or flexuose, hyaline, multiguttulate, 'at length one-septate' (Grove), 40–50 × 2–3μ.

On *Prunus avium* (Massee); wild cherry (Phillips).

The pycnidial stage of *Dermatea Cerasi* (Pers.) de Not., syn. *Cenangium Cerasi* (Pers.) Massee. Recorded for Britain by Phillips in *British Discomycetes*, p. 341, without name, and by Massee in *British Fungus Flora*, iv, 117, as *Micropera drupacearum*.

Micropera spuria (Fr.) v. Höhn. C. No. 950 (1916); *Sphaeronaema spurium* (Fr.) Sacc. *Syll. Fung.* iii, 186 (1884); *Ceratostoma spurium* Fr. *Obs.* ii, 338 (1818).

Pycnidial processes erumpent from an immersed white stroma, solitary or caespitose, conico-cylindrical, up to 3 mm. high, fragile, pulverulent, blackish brown; wall hyaline internally, brown externally; sporidia fusoid, curved, continuous, 18–24 × 3–4μ.

On *Prunus spinosa* (Phillips, Massee); *P. domestica* (Grove).

The pycnidial stage of *Dermatea prunastri* (Pers.) Fr., syn. *Phaeangella prunastri* (Pers.) Massee. Recorded for Britain by Phillips, p. 345, without name (sporidia 15 × 2μ, one-septate), and by Massee, p. 138, as *Sphaeronaema spurium* (sporidia 15 × 1·5–2μ, one-septate).

Micropera padina (Pers.-Mougeot) Sacc., *Michelia*, ii, 104; *Sphaeronaema brunneoviride* Auers. in herb.

Pycnidial processes subsolitary, ferruginous, apex blackening, conical, umbilicate above, then subpezizoid; sporophores short, filiform; sporidia cylindrico-fusoid, hyaline, 25–30 × 3·5–4μ.

On *Prunus Padus*. Cwm Llwch and Cerrig Gleisau (Grove). Grove's record on plum is withdrawn in ii, 361.

The pycnidial stage of *Dermatea Padi* (A. & S.) Fr., which is not recorded for Britain by Phillips or Massee.

Micropera Cotoneastri (Fr.) Sacc. *Syll. Fung.* iii, 605 (1884); *Sphaeria Cotoneastri* Fr. in Kunze, *Myk. Heft*, ii, 46; *Sphaeronaema pallidum* Peck, *25th Report*, p. 85; *Micropera Sorbi* (Fr.) Sacc. *Syll. Fung.* iii, 605 (1884), *teste* von Höhn. in C. No. 955 (1916); Grove, i, 448.

Pycnidial processes imperfect, loosely gregarious, up to 400μ diameter, 350μ high, erumpent but not prominent, conical, truncate, dark red-brown; texture of very small cells; sporophores verticillately branched (simple, v. Höhn.), 20–25 × 2·5μ (15–20 × 2–3μ, v. Höhn.), arising from a fuscous violet (Grove) (pale reddish, v. Höhn.) basal stratum; sporidia fusoid, acute, curved, continuous, 15–16 × 0·75–2μ.

On *Sorbus Aucuparia*, Bidston Hill, Cheshire (Grove).

According to Fuckel, the pycnidial stage of *Cenangium inconstans* (Fr.), which is not recorded for Britain by Phillips or Massee.

Micropera versiformis (A. & S.) Grove, II, 361; *Sphaeronaema versiforme* (A. & S.) Fr. *Scler. Suec.* III, No. 102; *Sphaeria versiformis* A. & S. *Consp. Fung.* p. 52 (1805).

Pycnidial processes conico-globose, with a minute pore at the apex; sporidia elongated ovoid, straight or slightly curved, hyaline, continuous, about $25 \times 6{\cdot}5\,\mu$.

On *Rhamnus frangula*, Shere; Highgate.

The pycnidial stage of *Dermatea Frangulae* Tul., syn. *Scleroderris Frangulae* Massee. Recorded for Britain by Phillips, p. 351, without name, and by Massee, p. 123, as *Sphaeronaema versiforme*.

Nannfeldt (1932) remarked that it was very doubtful whether *Dermatea Morthieri* (*Cenangium Morthieri* Fuckel) and its pycnidial stage, *Micula Mougeotii* Duby, were distinct from *Dermatea Frangulae* and *Sphaeronaema versiforme* respectively. The sporidia of *Micula Mougeotii*, syn. *Atractium Therryanum* Sacc., are said to be $46–50 \times 2–3\,\mu$.

Micropera turgida (B. & Br.) v. Höhn. F. No. 34 (1917); *Cryptosporium turgidum* B. & Br. *Ann. Mag. Nat. Hist.* (5), VII, 129 (1881).

Pycnidial processes scattered or fasciculate, dark-coloured, leathery, globose, ovate or shortly clavate, finally becoming patellate; sporophores simple, moderately long, about $30 \times 3\,\mu$; sporidia hyaline, continuous, fusoid, ends acute, straight or generally curved, $20–30 \times 4–5\,\mu$.

On *Fraxinus excelsior*, Twycross (Bloxam).

The pycnidial stage of *Dermatea Fraxini* (Tul.) v. Höhn. Not recorded by Phillips or Massee for Britain, but Massee's description of *Tympanis Fraxini* relates to an American species, *Godronia Fraxini* (Schw.) v. Höhn., *teste* von Höhn. F. No. 34 (1917).

DOTHIORINA von Höhn. C. No. 714 (1911)

Type species, *Dothiorina Tulasnei* (Sacc.) v. Höhn. C. No. 714 (1911).

Stromata pulvinate to globose, often confluent, superficial, fleshy, composed of almost parallel, vertical, very slender hyphae. Pycnidial loculi immersed, crowded, radially elongated, ostiolate, densely lined with linear, simple or fasciculately branched sporophores. Sporidia hyaline, small, rod-shaped.

Dothiorina Tulasnei (Sacc.) v. Höhn. C. No. 714 (1911); *Dothiorella Tulasnei* Sacc. *Syll. Fung.* III, 239 (1884); *sine nomine*, Tulasne, *Sel. Fung. Carp.* III, 188, Pl. XX, figs. 15–18.

Stroma even or tuberculate, dark green, paler internally, the exterior becoming black and somewhat carbonaceous when old; sporidia rod-shaped, continuous, straight, $3–5 \times 1\,\mu$.

On wood coloured by *Chlorosplenium*. North Wootton, March 1942.

The pycnidial stage of *Chlorosplenium aeruginosum* (Oed.) de Not., with the ascigerous stage, or independently on wood coloured green by the latter.

von Höhn. C. No. 714 (1911) placed this genus in the Nectrioideae, but in F. No. 74 (1918) he stated that it belonged to the Stromaceae (Pachystromaceae-carnosae).

ADDENDA

In C. No. 548 (1910) von Höhnel placed the following genus in the Nectrioideae, but in his key in his *System der Fungi Imperfecti* it is placed in the Sphaerioideae. Grove has it in Nectrioideae.

ERIOSPORA B. & Br. *Ann. Mag. Nat. Hist.* (2), v, 455 (1850)

Type species, *Eriospora leucostoma* B. & Br. *Ann. Mag. Nat. Hist.* (2), v, 455 (1850).

Stroma multilocular; loculi flattened globose, with a common orifice; wall thick, with a dark outer layer and a more or less gelatinous, hyaline, inner layer; sporidia filiform, several at the apex of a rod-like sporophore.

ERIOSPORA LEUCOSTOMA B. & Br. Spots pitchy black. Stromata depressed, effused, thin, margined, scarcely 2 mm. broad, multilocular, dehiscing in the centre by a papillate white-bordered, pulverulent opening; loculi varying in number, subglobose or confluent and flattened; sporidia (or spore appendages) filiform, often curved or hooked at the upper end, 50–70 × 0·75–1 μ, seated in bundles of three to six on a short cylindrical or oblong base or pedicel (Grove, II, 120).

On dead leaves of *Typha*, Spye Park, Wilts, February 1850; apparently not found again in this country.

This species was reported from Germany, on *Carex sylvatica* and *C. stricta*, by Fuckel, who issued specimens in *Fungi Rhenani*, No. 1726. These were examined by von Höhnel, who described them in C. No. 548 (1910). His description differs in several respects from those of Berkeley and Broome, and Grove, and is quoted below in some detail.

According to von Höhnel, the fungus is not multilocular. It has simple, gelatinous-fleshy pycnidia, 300-400 μ broad, circular, often somewhat elongated, slightly depressed, immersed beneath the epidermis. The wall consists of two layers. The outer layer is 6–7 μ thick, yellow-brownish, soft and of indeterminate structure, containing concretions (? of calcium oxalate), and not sharply limited from the surrounding tissue. The inner layer is hyaline, soft, gelatinous, 25–35 μ thick, and contains a network of hyaline hyphae, 1 μ broad, with meshes, 5–7 μ broad. From this network arise distant, hyaline, simple, inwardly directed rods, about 6–8 × 1 μ, which bear at the apex 2–6 linear, one-celled, straight or slightly curved, hyaline spores, up to 100 × 0·7 μ. The spores may be extruded singly, but often attached to the basal rod. The fungus breaks through the epidermis with a cylindrical, flattened, not projecting, white ostiolar papilla, 60–70 μ broad and about 80 μ high. The tissue of the papilla consists of hyaline, thick-walled, soft cells, 2–3 μ diameter which merge gradually into the gelatinous inner layer of the pycnidium. The ostiolum is inconspicuous, and the host tissue is browned round the small flat ostiolar disc.

Zythia Fragariae Laibach, *Arb. biol. Anst. Berl.* VI, 79 (1908); *Phyllosticta grandimaculans* Bubák & Krieger, *Ann. Mycol.* X, 46 (1912).

Pycnidia amphigenous, immersed, appearing as dark, but not black, dots, then erumpent, whitish, wall pale brown when old, globoso-conoid, up to 0·3 mm. diameter; sporophores simple or branched near the base, conoid or flask-shaped, 12–18 × 2 μ, sometimes bulbous and 3 μ diameter at the base, apex acute; sporidia cylindrical, ends rounded and guttulate, 5–7 × 2 μ.

On pale yellowish brown blotches with a narrow dark purple border on leaves of strawberry. Kent and Gloucestershire (Dr H. Wormald).

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THE LIFE HISTORY OF *PHYTOPHTHORA CACTORUM* (LEB. & COHN) SCHROET.

By ELIZABETH BLACKWELL, *Royal Holloway College*

(With 7 Text-figures)

The strain

Twenty years ago, at the Imperial College of Science, London, Mr R. J. Tabor gave me a tube culture of *Phytophthora Cactorum* (Leb. & Cohn) Schroet., a strain which he had obtained from the Centraalbureau voor Schimmelcultures, Baarn, Holland, and he suggested that I should report on it. He informed me that although the structure and development of a *Phytophthora* with amphigynous antheridia had recently been described (Pethybridge, 1913, 1914; Murphy, 1918), the life history of a species with paragynous antheridia had not been told, and as far as I know this is still true to-day. My report was read at a meeting of the British Mycological Society in 1925 but was not published because, at that time, oospores had not been germinated in sufficient quantity to give all the stages of germination. Since then, however, oospores have been obtained in great numbers by a method of refrigeration (Blackwell, 1935).

The history of the species

The species was erected by Lebert and Cohn (1871) for an oomycete they found causing a rot of cacti. They called it *Peronospora Cactorum*. The Latin diagnosis sufficiently applies to the fungus here described, and the two text-figures satisfactorily illustrate it.

De Bary (1876) proposed a new genus *Phytophthora* based on *Peronospora infestans*.

Further species of *Phytophthora* were then recognized, and these de Bary (1881) collected, together with *P. Cactorum*, into an omnibus species *P. omnivora*. He recognized the validity of the name *P. Cactorum* but considered *P. omnivora* more suitable.

Schroeter, however (1886), recognized the original specific epithet *Cactorum*, and *Phytophthora Cactorum* it remains to this day.

Parasitism

Diseases of a number of plants and parts of plants, e.g. crown rot, foot rot, root rot, die back, damping off, have been attributed to *Phytophthora Cactorum* among such widely different genera as *Cereus*, *Acer*, *Pyrus*, *Paeonia*, *Rheum*, *Fagus*, *Pinus* and others. The species comprises a number of distinct strains (Tucker, 1931, 1933).

Cultivation

In the early days of the investigation the fungus was grown on potato mush agar at a temperature of 22° C. Trials on prune agar and malt agar gave a much thinner growth; prune agar proved useful in encouraging sporangial

production. On malt agar the growth was stunted, the mycelium being not only sparse but nodular. Latterly it has been conveniently grown at laboratory temperature (15–20° C.) on ground Quaker-oat agar, oatmeal agar or bean agar for production of oospores, and on Difco corn-meal agar for production of sporangia. It is, however, easily enough cultivated on a variety of media, and it can endure a wide range of temperature. It has been subcultured continuously in the laboratory these twenty years, and during this prolonged saprophytic existence no change has been observed in its vigour, or in size and abundance of reproductive organs. A subculture was sent to Professor Leonian in 1940 who wrote: 'I have examined the culture and find it to be a typical one.'

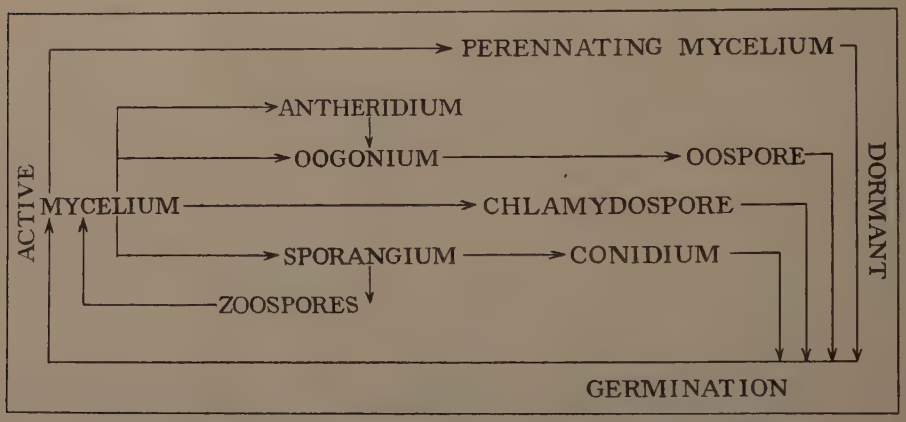


Fig. 1. A diagrammatic representation of the life cycle of *Phytophthora Cactorum*.

Vegetative growth and form of the mycelium

The macroscopic appearance of the mycelium varies with the medium in which it is growing. It is sometimes abundant and fluffy and sometimes sparse and close, and in slightly acid water it is fine and free with abundant sporangia on long thin hyphae reaching up to the surface of the water.

Microscopically it shows the right-angled branching characteristic of the genus, with a slight constriction at the base of each branch (Fig. 4). The hyphae are variable in diameter (2–14μ); they are slender and slightly branched in a watery medium; but short, thick and much branched, even swollen and nodular, in a medium that is highly concentrated and relatively dry. For the most part when not under extreme conditions hyphae measure 4–5μ across and branch frequently, rather more vigorously on one side than the other; but vegetative branching is always monopodial, in contrast to the unichasial sympodium of the sporangiophore. As the culture develops the main straight hyphae grow along the surface of the agar, giving off lateral branches both immersed and emergent. Growth is at the tip of each branch and here the nuclei divide. There is often a nucleus at the base of a newly formed branch: presumably the sister nucleus of that which passed into the young branch. Nuclei are distributed singly

and evenly throughout young hyphae at intervals of 10–20μ apart, with sap vacuoles between them. There is constant movement of the protoplasm, and vacuoles can be watched forming and changing shape and running together. The wall at the tip of each young growing hypha is thin and extensible and permeable and it gives a slight reaction for cellulose but none for pectic substances and none for chitin. It is here that absorption of nutrients takes place as well as growth in length. Older hyphae have a film of protoplasm lining the wall, in which the nuclei are not readily discernible; while the central, almost continuous vacuole is packed with highly refringent oil reserves. Cross-walls are formed in young hyphae only at the base of the reproductive organs: in older hyphae they may be anywhere and may be frequent. They are often accompanied by an extra plug of cellulose. The old hyphal walls are very resistant but these, too, give no reaction for pectic substances or chitin.

Mode of origin of the mycelium

Provided that oxygen, water and food are available, and staling substances are removed, the mycelium appears to have almost unlimited growth; and has extraordinary powers of resistance and recuperation. If it is not completely desiccated, it can lie dormant for months at just above freezing point and then revive in water. Indeed, the usual laboratory method of propagation has been by inoculation of a fresh nutrient medium with a piece of vegetative mycelium. In old, dormant mycelia portions of hyphae are plugged off from the rest. These include protoplasm packed with oil reserves, and have a 'glassy' look. It is this dormant protoplasm (Fig. 2 *f*) that renews the growth of the mycelium.

In addition to these irregular pieces of dormant hyphae, there are rarely developed, and as a rule only in water, spherical portions that can renew the growth by putting out fresh hyphae (Fig. 2 *g*). They are comparable with the sphaero-conidia described by Lafferty and Pethybridge (1922).

There are four kinds of resting spore that give germ tubes through a pore in the resistant wall: conidium (Fig. 2 *b*), resting conidium (Fig. 2 *c*), chlamydospore (Fig. 2 *d*) and oospore (Fig. 2 *e*). No hard and fast line can be drawn between the first three of these (Blackwell & Waterhouse, 1931).

In young fresh cultures in a saturated atmosphere, the mycelium is constantly originated by the germination of zoospores liberated from sporangia (Fig. 2 *a*, *s*).

Comparative review of the spores which originate new mycelium

The oospore, retained within its oogonium wall, is formed from the oosphere on fertilization by a nucleus from an antheridium. It has a most resistant double envelope: (1) the oogonium wall, and (2) the oospore wall which is thickly lined with a layer of reserves. In the dormant state it is uninucleate, becoming multinucleate on preparation for germination.

The chlamydospore has a single envelope which is sooner or later lined with a layer of reserves and it is superficially like the oospore but the absence of the oogonium wall and applied antheridium serves to distinguish it.

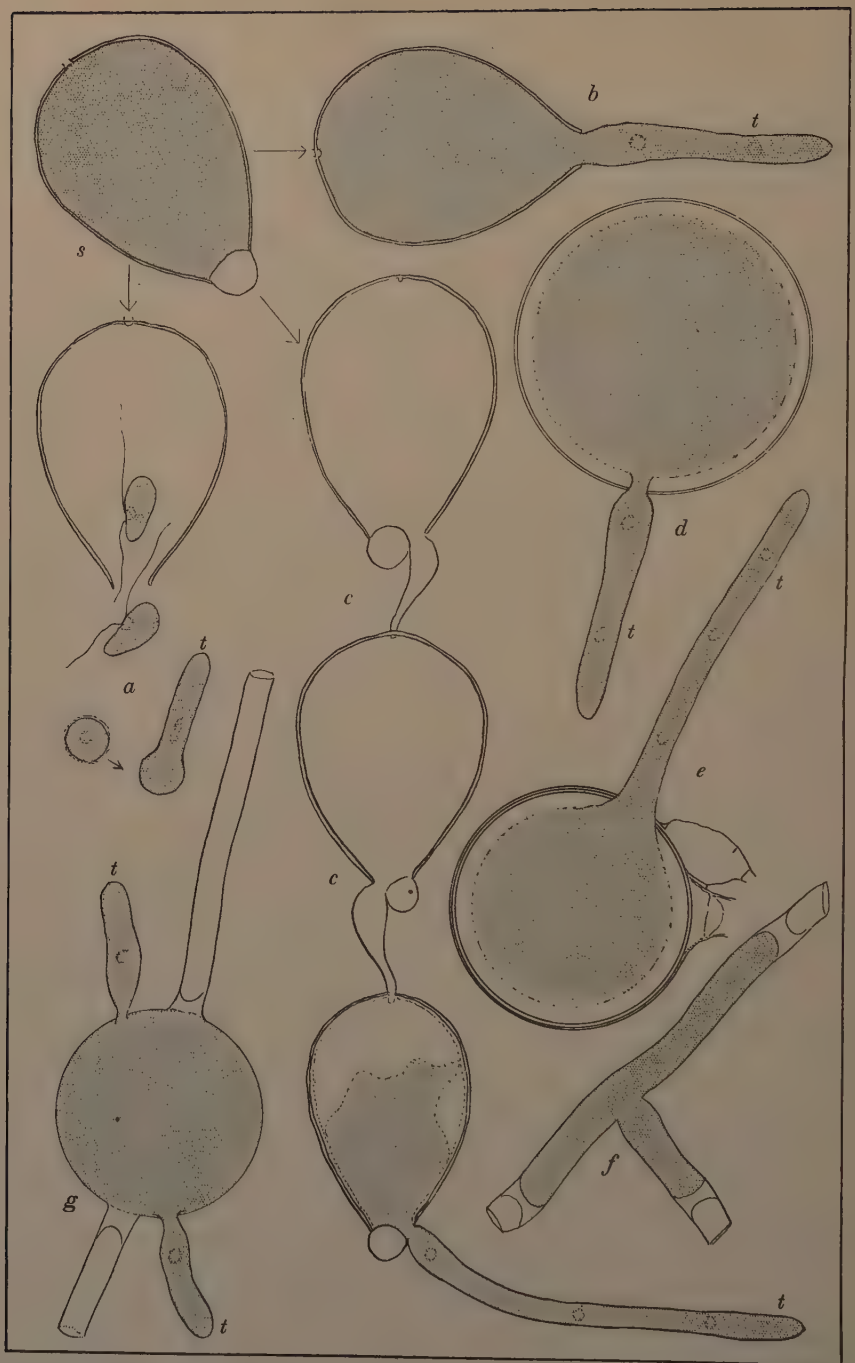


Fig. 2. The different initials from which the mycelium may be originated. (*a*) germinating zoospore, (*b*) conidium, (*c*) resting conidium, (*d*) chlamydospore, (*e*) oospore, (*f*) perennating mycelium, (*g*) 'sphaero-conidium', (*s*) the sporangium which by indirect germination may give zoospores or may develop into a conidium, (*t*) germ tube. (As seen in optical section × 1000; semi-diagrammatic.)

It is, as a rule, larger than the oospore and is formed under uneven conditions of alternating heat and cold, damp and drought. It is multinucleate from the first.

The conidium although arising like a thin-walled chlamydospore differs typically in the thinner lining of reserves and the presence of a papilla. It is ovoid and multinucleate and was initiated as a sporangium but failed to come into contact with fresh water until too late for the protoplasm to break up into zoospores.

The zoospore is liberated as a small, pear-shaped, uninucleate, biflagellate motile spore from the ovoid papillate sporangium.

All these spores germinate by giving germ tubes.

The germ tube of the zoospore is at first uninucleate but that of the oospore, the conidium and the chlamydospore is multinucleate and, as it grows, more nuclei pass out from the spore into the young hypha.

The germ tube of the zoospore, conidium and chlamydospore grows from an asexual spore and takes up again the interrupted growth of the parent mycelium; whereas that of the oospore starts a new individual: the result of a fusion of two nuclei.

The zoospore germinates at once or dies, as it cannot withstand drought. Conidia and chlamydospores can withstand drought, but on addition of water they germinate more or less readily. The oospore germinates only after a period of rest and under very narrowly limited conditions which are not easily determined.

Conidia, chlamydospores and oospores are *perennating* spores and of these the oospore is highly resistant. All three seem to be quite immune to the action of bacteria as long as they remain dormant.

The oospore is unique among the resting spores in that it comes in the natural sequence of growth in the life cycle of the fungus. Once the mycelium is established the production of sporangia and oogonia, with antheridia, follows, and under conditions of accumulation of staling substances, drought, inconstant temperature and such like are the other resting spores formed. It is unique too in that it forms a highly resistant wall *within* the parent hyphal wall (which is the oogonium wall), the other spores using the parent hyphal wall as their resistant wall. Thirdly it is unique in its need of a period of rest. During a period after maturation it is extremely difficult, if not impossible, to induce germination by any artificial means. Apart from this, all the other characteristics of dormancy are shared in common with the other perennating organs: viz. protoplasm with a minimum of imbibed water, reserves of food material, and an impermeable wall.

Production of spores

Reproductive organs are readily and abundantly produced in culture and may appear at once. A good supply of oxygen, water and nutrients encourages vegetative growth at first, but within two or three days both sporangia and oogonia, with antheridia, may be formed. In a fresh culture on ground Quaker-oat agar grown on the laboratory bench (usually about 14° C., but varying between 7 and 24° C.) oogonia can be found on the second day after inoculation, and later in abundance with an occasional

sporangium. On the other hand, in a fresh culture on Difco corn-meal agar, or in water only, sporangia appear on the second day, and later in abundance, with a few oogonia. Sporangia that will give zoospores are most readily obtained in fresh cultures growing in fresh media. If, however, these sporangia, while freshly ripe, do not originate zoospores they mature into conidia which germinate directly by germ tube. The conditions of germination are the same for both, viz. fresh water bringing oxygen and a relatively lower temperature. Sporangia are undoubtedly the means of rapid multiplication when water is present, be it only a film of water or a saturated atmosphere; for both water and air are necessary for their production (Waterhouse, 1931).

Sporangium

Sporangia form very rapidly on slender emergent hyphae which may be called sporangiophores. As a rule they are less than half the diameter of the hyphae from which they arise (Fig. 3 *a*, *b*). Both the formation of sporangia on a unichasial sympodium and the emission of zoospores from each sporangium in turn as it ripens can be watched and timed. From the initiation of the sporangiophore to the production of the ripe sporangium may be as little as six hours. Fig. 3 *b* is a record of one such observation. Instead of growing forward in length the hypha swells at the tip while at the same time the nuclei continue to divide. This multinucleate sphere becomes ovoid and develops a beak; and it is cut off from the slender sporangiophore by a thin cross-wall. The wall of the sporangium is now differentiated into at least two layers, and at the beak the inner layer is very thick and mucilaginous forming the papilla. Elsewhere the wall is thin, firm and very resistant.

Sporangia vary very much in size according to the conditions under which they are produced. A large one may measure $45 \times 33\mu$ and a small one $28 \times 20\mu$, and abnormally they may be larger or smaller, but a typical one is about $36 \times 28\mu$. In shape, however, they are very constant. The cross diameter is always more than two-thirds the length, including the papilla, which is anything from 3 to 6μ. The number of nuclei in the sporangium varies with the size, but a typical one contains about thirty nuclei evenly distributed in the finely vacuolate protoplasm. There may or may not be an evident sap vacuole in the centre.

If the water in which the sporangium has just developed is still fresh, or better if cooler fresh water be supplied, the protoplasm of the sporangium is divided quickly and completely into uninucleate portions (Fig. 3 *c*). These portions become condensed and round themselves off, giving sap into the interstices so that finally they can move about in this fluid. They gradually assume their characteristic pear shape and develop two lateral flagella. The papilla then absorbs water, and after breaking a thin outer pellicle, it rapidly expands into an evanescent vesicle, which however is not always easy to see. Some of the zoospores are held within it for a fleeting moment and then it bursts and they swim rapidly away, followed more slowly by the remaining zoospores if the water is becoming stale, when the last zoospores take some time to emerge. In fact they may germi-

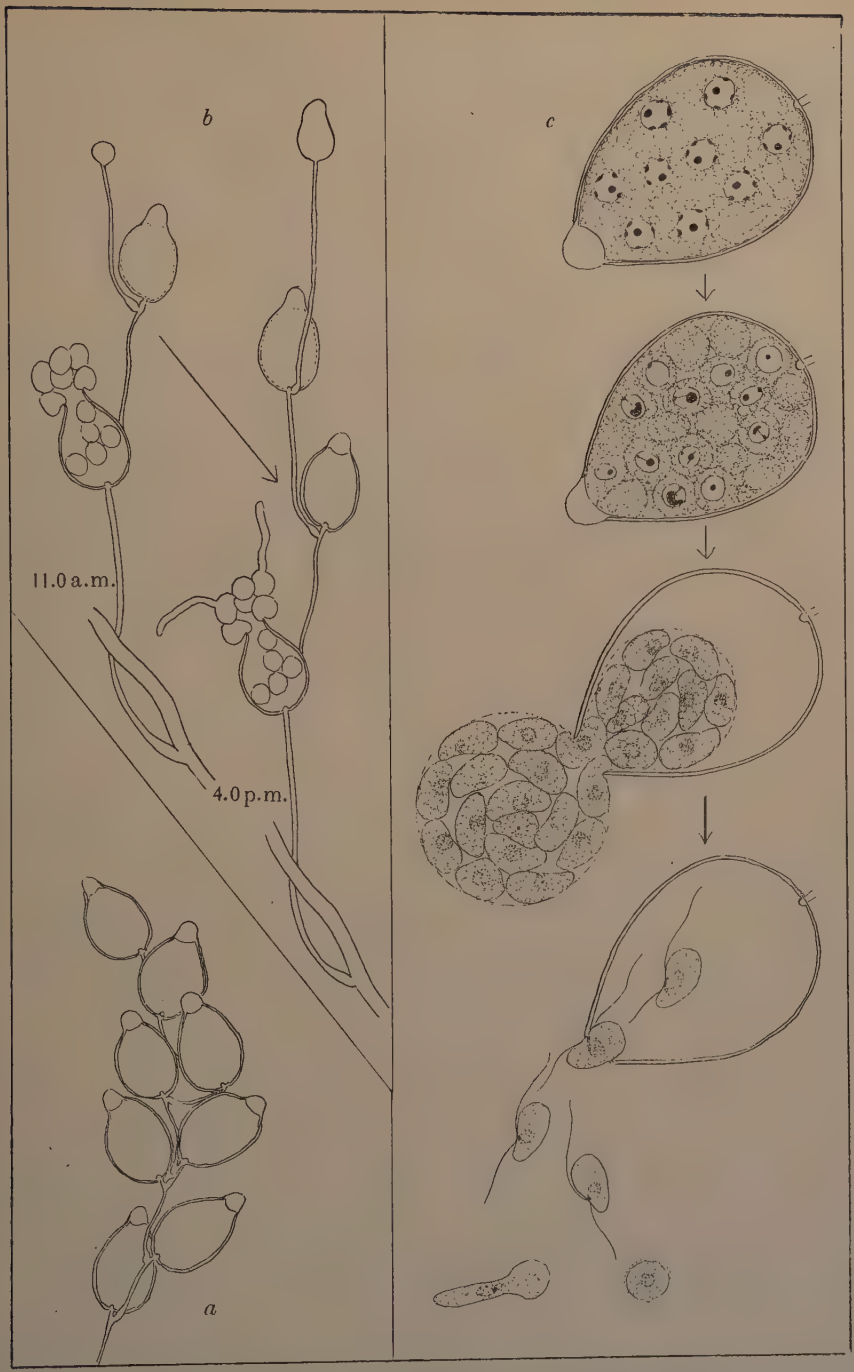


Fig. 3. The sporangiophore, sporangium and zoospore. (*a*) unichasial sympodium of a sporangiophore grown in a moist atmosphere (in outline only. × 400). (*b*) unichasial sympodium of a sporangiophore grown under water, drawn at two stages of its growth, five hours apart. The zoospores have been emitted from the oldest sporangium and have settled at the mouth and begun to germinate there (in outline only. × 400). (*c*) formation of zoospores within a sporangium and their emission in a vesicle developed from the papilla. (Composite drawing, × 1000. The two upper figures, as seen in median longitudinal section.)

nate within the sporangium (Fig. 3 *b*). The emission of the zoospores from the sporangium has been precisely described by Wormald (1919), and the structure of the pear-shaped, uninucleate, biflagellate zoospore of another *Phytophthora* has been illustrated by Cotner (1930) and by Couch (1941). The zoospores swim for about an hour, then settle down, round off and put out a germ tube. This has been called indirect germination of the sporangium. From formation to germination may be only two or three hours, but no doubt the motile phase may be prolonged.

Monospore cultures of zoospores give mycelia as before bearing all the various reproductive organs and thus demonstrate homothallism.

With continual supplies of fresh water, or in a saturated atmosphere, successive sporangia are soon formed by the growth of a hypha from below the basal cross wall, outside the earlier one (Figs. 3, 4). The 'Pythiomorpha' type of proliferation (Blackwell, Waterhouse & Thompson, 1941), where a new sporangium arises from a hypha pushed up into the emptied sporangium, has not been observed in this species even when it is growing in water. The basal plug prevents growth inwards at this point and the new branch of the sporangiophore must grow out immediately below the earlier sporangium pushing it to one side.

The swelling at the base of each branch of the sporangiophore which de Bary (1876) figured for *Phytophthora infestans* and claimed as one of the characters of the genus *Phytophthora* as opposed to *Peronospora* is shown in Fig. 4 *e*.

Conidium

If the sporangium has not given zoospores it ripens into a conidium; and in old cultures in staling media conidia only are developed. Chemical changes in both basal plug and papilla render them less extensible and the protoplasm accumulates fatty reserves in a central globule and deposits a thin layer of cellulose upon the wall. Once the conidium has entered upon these maturation changes it seems unable to produce zoospores under any circumstances. It must germinate by a germ tube. The germ tube, however, may grow straight through the still soft papilla and emerge apically. It is multinucleate from the first for into it pass the nuclei of the multinucleate conidium.

Resting conidium

If kept moderately dry the conidium may rest for months, the papilla becoming harder and the wall layer of reserves thicker. Accordingly when water is supplied the germ tube cannot always emerge through it; instead the papilla must be pushed aside and an exit forced about its base. There may be more than one germ tube each forcing a separate exit. In an old culture chains of conidia are found all empty except for the last one produced, as though from time to time enough water for germination has been available (water of condensation perhaps caused by a fall in temperature) followed immediately by conditions that encourage conidial formation, e.g. a drying or staling medium. As a certain amount of reserve has been used up in the short period of growth, each newly formed conidium is rather smaller than the previous one (Fig. 2 *c*). Given the right conditions for vegetative

growth a conidium may give rise to vegetative hyphae, or to a sporangium or even to an oogonium with antheridium (Fig. 4).

Chlamydospore

A similar resting spore and one that cannot be sharply distinguished from the resting conidium is called a chlamydospore. Chlamydospores appear in great abundance in an old culture that has been subjected to wide extremes of temperature. They are usually terminal, rarely intercalary. They vary in size and in number of nuclei even more than sporangia and conidia vary. A typical chlamydospore differs from a typical conidium in being quite spherical, in having no papilla and in having a thicker layer of reserves inside the wall in addition to the oil reserves. It germinates fairly readily by a multinucleate germ-tube.

The chlamydospore is so frequently confused with the oospore that the following distinguishing features may usefully be stressed. It is not developed free of the hyphal wall as is the oospore within its oogonium, to which is usually conspicuously attached the antheridium; it stores oil but never in a single large oil globule; between crossed nicols the wall is very much brighter than the oospore, and this is the surest method of distinguishing them.

Oogonia and antheridia

The oogonia and antheridia are initiated on adjoining lateral branches either submerged or emergent. They are first observed as a rule at the stage shown in Figs. 5 *a* and 4 *a*, *b*, where the tips of these neighbouring hyphae have met and expanded into two equal-sized, multinucleate spherical heads. Soon one swollen hyphal tip becomes larger than the other with more nuclei and can then be recognized as the oogonial initial; the other, the antheridial initial, shows very little further enlargement and so comes to lie on the neck of the swelling oogonium. It is not known what determines which of these two organs shall be the oogonium. It is observed, however, that the hypha bearing the antheridium is usually more slender than that bearing the oogonium, which suggests that available food may be a determining factor; as, however, the difference in size of the hyphae is more marked in the later stages, this may be an effect rather than the cause. It has been observed, too, that the antheridial branch is borne nearer to the growing point of the hypha that has produced the pair of lateral branches (Fig. 4 *a*, *b*).

The two organs are soon firmly attached by their walls, as with a sticky secretion, so that any injury serves only to tear them from their hyphal stalks, never from one another. They assume their maximum size in an hour or so when the diameter of the oogonium varies from 25 to 40μ (generally about 33μ), and the longest diameter of the antheridium from 12 to 15μ. The nuclei of each swelling tip divide two or three times so that each organ finally contains a number of nuclei: the oogonium rather less than thirty and the antheridium usually less than ten (Fig. 5 *b*). In this condition they may be found in great numbers between 8.0 and 10.0 a.m. on a mycelium that the previous night showed no signs of reproductive

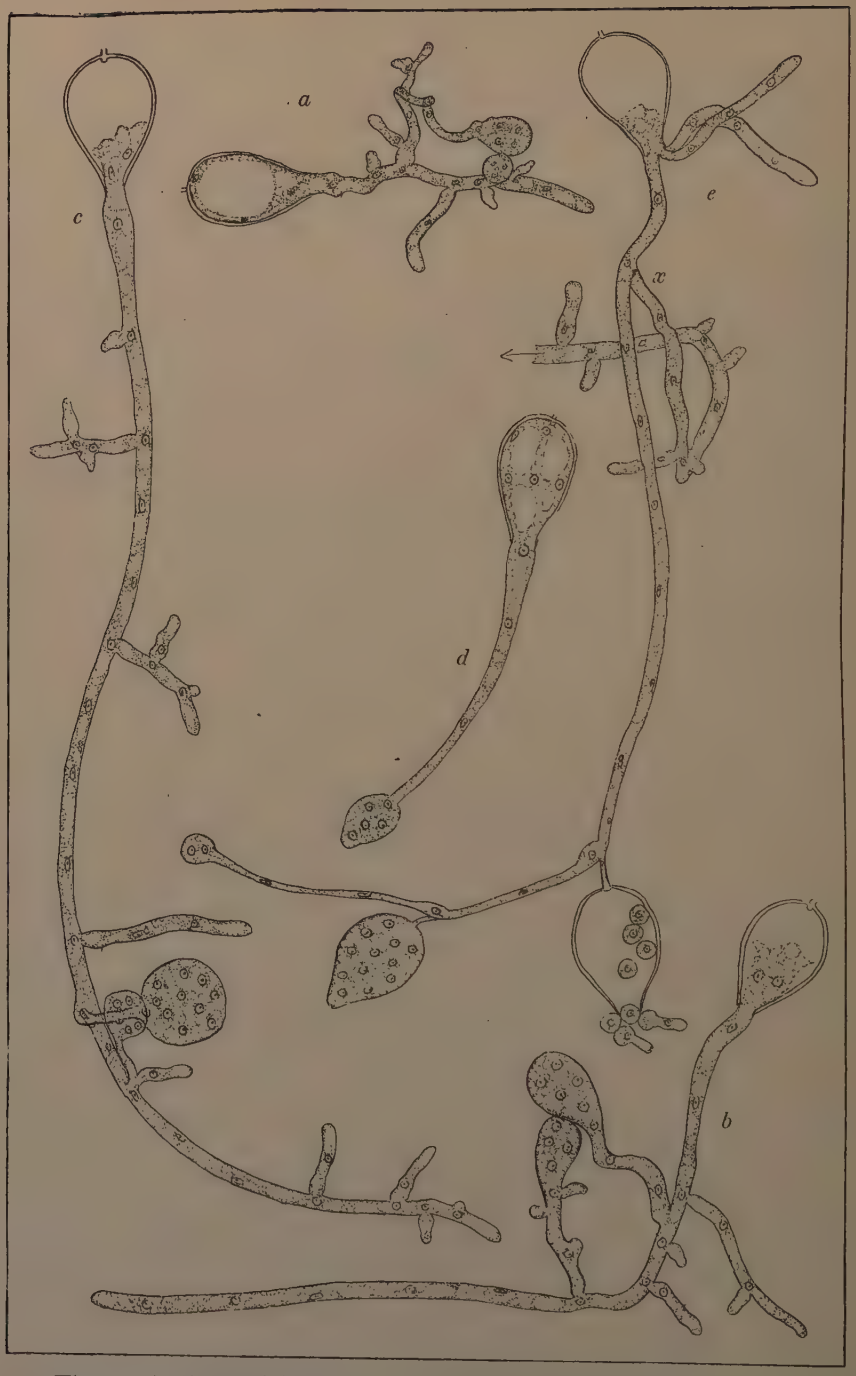


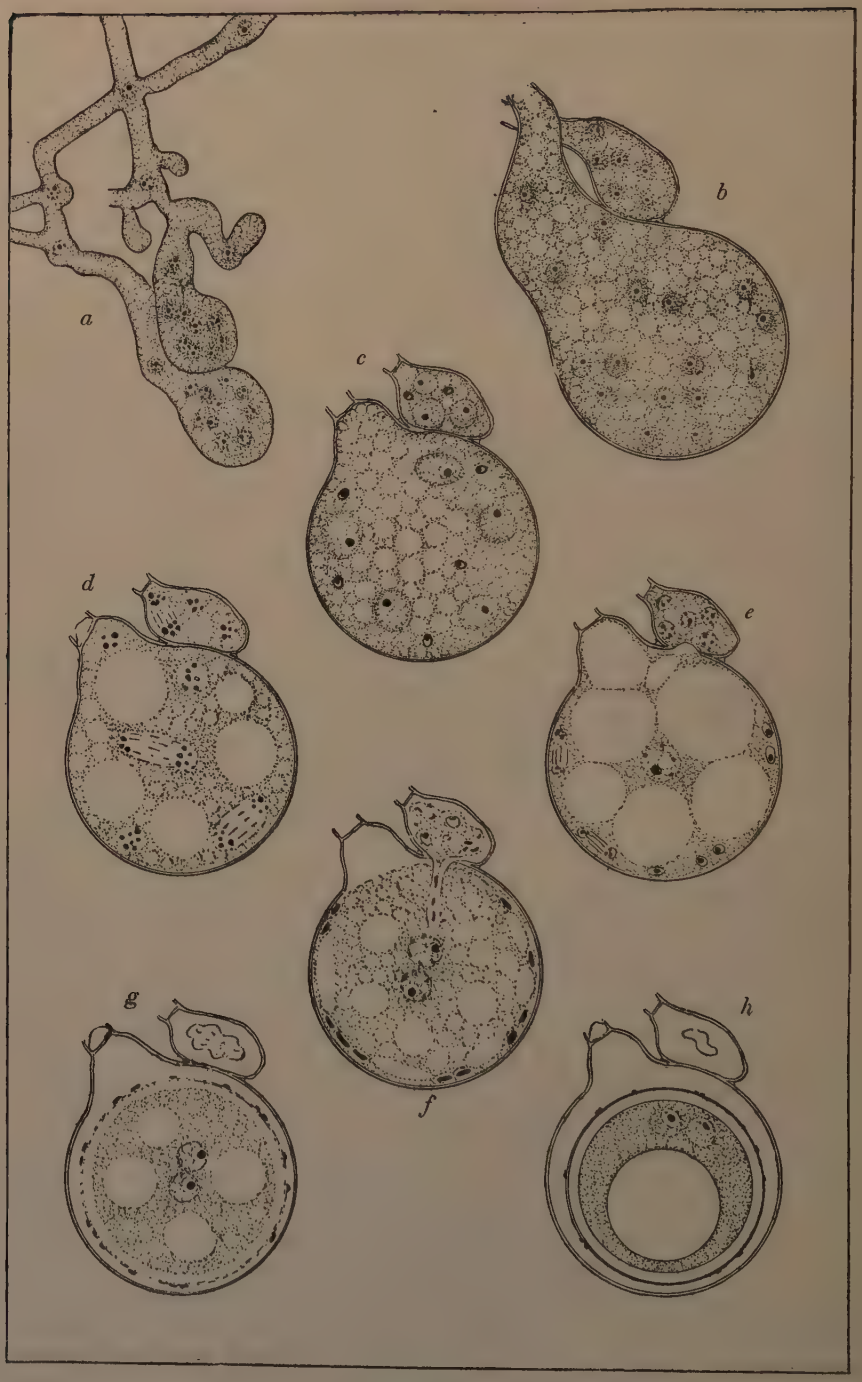
Fig. 4. The germinating conidium. ×450. All these conidia and many others were found germinating in a seven-months-old culture that had been soaked for two days in dilute apple juice. Some conidia had given mycelia without reproductive organs. The age of the conidia is not known. (*a*), (*b*) and (*c*) had germinated to give oogonium and antheridium in two days. (*a*) and (*b*) have paragynous antheridia and (*c*) an amphigynous antheridium. (*d*) had germinated to give a sporangium in two days. (*e*) from the same culture after four days was found to have three germ tubes: the longest of these had forked to give a branch bearing an oogonium and antheridium which later died at the fork (*x*), and another branch which became a sporangiophore.

organs. After a septum has formed cutting off each reproductive organ from its parent hypha (and the antheridial septum is always formed first) the protoplasm becomes more vacuolate, and the nuclei are reduced in number (the presence of deeply stainable bodies in the protoplasm suggests that some have degenerated) (Fig. 5 *c*). In the forenoon of the same day the majority of the oogonia have eight or nine large resting nuclei disposed equidistantly from one another with large sap vacuoles in between, and the majority of the antheridia have four or five equally large and well-defined nuclei (Fig. 5 *c*). About noon they all divide simultaneously (Fig. 5 *d*). This process is very conspicuous, rather drawn out so that stages can therefore readily be fixed in the late forenoon. The eight or more nuclei of the antheridium and the sixteen or more nuclei of the oogonium now arrange themselves evenly throughout the vacuolate protoplasm, but in the oogonium a nucleus in the centre gradually assumes dominance and by the next morning there is a mass of ooplasm with one central nucleus which may be termed the oosphere, delimited from the thin periplasm with the rest of the nuclei (Fig. 5 *e*). The fertilization tube which appears to be an extension of the fused wall of oogonium and antheridium, bent by pressure first towards the antheridium (the so-called receptive papilla) and then towards the oogonium (the fertilization tube), passes right into the ooplasm and finally gives way, liberating one nucleus which fertilizes the oosphere (Fig. 5 *f*).

On occasion a few amphigynous antheridia are formed in some transfers, perhaps 1 % of the whole; but, as Murphy (1918) has shown, this in no way affects the normal course of fertilization.

The oospore

Immediately after the entry of the antheridial nucleus into the ooplasm, a thin limiting membrane forms and the young bi-nucleate oospore is delimited within the periplasm (Fig. 5 *g*). Material fixed between 7.0 and 9.0 a.m. shows this stage and sometimes, though infrequently, the fertilization tube, which is evidently of short duration. Material fixed and stained about noon with picro-nigrosin shows two to three dozen black dots distributed mostly in pairs, upon the still thin wall of the young oospore. They are presumably the nuclei of the periplasm after their last division before final degeneration. This thin nucleate protoplasm becomes closely applied to the oospore membrane and with it forms the exospore which therefore is entirely of protoplasmic origin. It immediately becomes very resistant, and subsequently the endospore accumulates upon the inner face of the membrane of the oospore, as a thick storage layer with a basis of cellulose and protein. Within the protoplasm numerous globules of oil form and later fuse into the characteristic excentric oil globule (Fig. 5 *h*). In the course of a month, and the period is longer at low temperature (5° C.), the nuclei fuse. Both the paired nuclei and later the fusion nucleus appear in a clear area which on application of 1 % osmic acid gives a sharp black reaction. This indicates that oil is in close association with the nuclei and suggests the possibility of a plastid which forms and divides with



Text-fig. 5.

the nucleus; but no definite body has so far been demonstrated by the stains and reagents used.

The protoplasm and nuclei left behind in the antheridium degenerate into an oily mass, and the antheridium rarely becomes quite empty. But it remains fixed to the oogonium wall until after the oospore germinates. It is rare to find an oogonium from which the antheridium has broken away. Such a rarity is, however, shown in Fig. 7 *a*.

During oospore formation the hyphae bearing the firmly attached oogonium and antheridium have grown and twisted together and thrown out other branches so that the whole is a tangle, and it is impossible to trace the origin of the two fertile branches. The oogonial and antheridial walls remain colourless and transparent but they have matured in different ways. In chlor-zinc-iodide the oogonium wall turns a violet blue and the antheridium a claret colour. With a more exact microchemical technique, it has been demonstrated that both walls have a basis of cellulose which is impregnated with substances that are different in the two organs. The septum across the oogonial stalk becomes thickly plugged on the side away from the oogonium with a substance that may be callose. It turns a striking greenish blue with lacmoid (resorcin blue).

The oospore now enters upon what may be months of dormancy. The dormant period may be said to begin when the oospore is at its minimum diameter lying loosely in its oogonial wall. The exospore is thin, smooth and transparent, built of pectic substances, most resistant and almost impermeable. Few stains can penetrate it, though spores left in aceto-carmine for a week show a faintly pink fusion nucleus. The endospore is composed of cellulose, protein and possibly other reserve substances and is at its thickest (2μ). The excentric oil globule is composed of fats in a high state of saturation, and not readily blackened by osmic acid. The colloids of the protoplasm hold a minimum of imbibed water and the protoplasm appears homogeneous, colourless and condensed. But the paired nuclei have not fused.

The first stage of dormancy, then, is this delay of fusion of the nuclei. The fusion nucleus when formed three, four or more weeks later continues to turn sharply black in osmic acid and the protoplasm to remain colourless.

It is important at this point to realize that each oospore is an independent product. It matures in its own time, with its own period of delay in fusion

Legend to Text-figure 5.

Fig. 5. Development of oogonium, antheridium and oospore. (*a*) initials of oogonium and antheridium (see also Fig. 4). (*b*) oogonium and antheridium grown to full size: the oogonium has about twenty-four nuclei and the antheridium about nine. (*c*) development of a septum at the base of each, and degeneration of some nuclei in each until the oogonium has eight or nine nuclei and the antheridium four or five. (*d*) a simultaneous division of the surviving nuclei in oogonium and antheridium. The protoplasm has large vacuoles. (*e*) separation of ooplasm from periplasm. Nuclei in division in periplasm prior to degeneration. Oogonium presses into antheridium. (*f*) entry of one antheridial nucleus by a fertilization tube. The protoplasm and remaining nuclei of the antheridium degenerate. (*g*) development of oospore wall. (*h*) oospore enters on its dormant period with exospore formed from dead periplasm; endospore (of cellulose, protein, etc.) deposited upon it, and paired nuclei in association but not yet fused. (*a*)–(*h*) are composite drawings of eight stages in sequence. × 1000.

of the paired nuclei, and its own individual deposit of reserves. One is reminded of this fact when watching oospores germinate: one at a time and never all together. The same external conditions have a different effect on different oospores.

Germination of the oospore

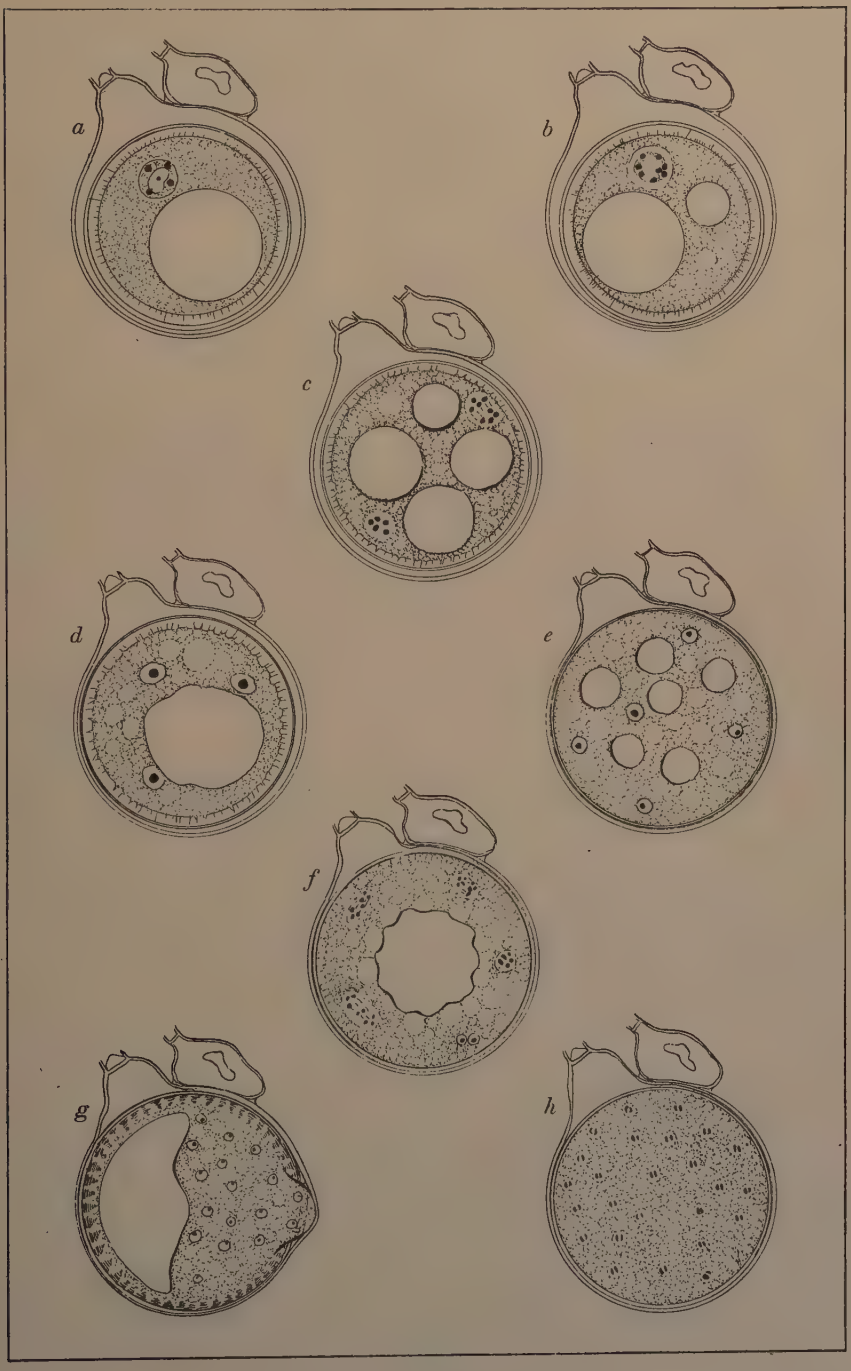
Before it can be germinated, the oospore requires a further period of dormancy. This is comparable to the period known as the 'after-ripening' of seeds. This period at laboratory temperature is a further six or seven months, but at a temperature just above freezing point it can be speeded up to one or two months. And when 'after-ripening' is completed the oospore may continue to lie dormant for many months more, if it is not germinated. The oospores during this threefold dormancy must be kept comparatively moist. Desiccation means death. It seems that inconceivably slow metabolic changes are proceeding in the living protoplasm and its included reserves. There cannot be an utter cessation of metabolism without death. It is difficult therefore to say when dormancy ends and preparation for germination begins.

Oospores prepared for germination have a characteristic dull, soft, granular appearance: the finely vacuolate protoplasm showing clearly through the transparent walls. They are very striking by contrast with dead spores which may be found lying among them and which look bright, hard and 'glassy'. The changes that have taken place in the living oospore are these. The spore has expanded so that it now almost entirely fills the oogonial cavity. Evidently the exospore has stretched, but not the oogonial wall. The oil globule once again turns black on application of osmic acid, but the action takes place at the surface of the globule and unevenly, giving smaller or larger black areas. The globule breaks up into smaller ones. Oospores at this stage may contain anything from one to ten globules and soon the latter disappear altogether as though mixed into the protoplasm which is now more ample and finely vacuolate. After the small oil globules have formed but before the oil is incorporated into the protoplasm the absorption of the endospore begins. This may take place as rapidly as it was earlier built up, or it may appear eroded as though half digested by enzyme action. Fine radiating passages in this wall suggest that the reserves of cellulose, protein, etc. are being digested at different rates.

While the succession of changes in the oil reserve and the endospore is proceeding concurrently but independently, the fusion nucleus is subdividing and thus initiating a succession of independent changes of its own.

Legend to Text-figure 6.

Fig. 6. The oospore towards the end of dormancy, between 'after-ripening' and germination. (*a*) and (*b*) fusion nucleus in division, oil globule breaking up, endospore becoming eroded. (*c*) second nuclear division, oil globule broken up. (*d*) four-nucleate stage, oil globule dispersing gradually. (*e*) eight-nucleate stage, oil globules further subdivided, endospore almost completely absorbed. (*f*) fourth nuclear division, oil globule still single, endospore almost completely absorbed. (*g*) about thirty-two nuclei, oil globule still single, endospore not yet absorbed, germ tube through exospore but not yet through oogonium wall. (*h*) sixth nuclear division, nuclei very small, all reserves absorbed into protoplasm but germ tube not yet formed. (*a*)–(*h*) are composite drawings of median longitudinal sections (× 1000) not representing a sequence of stages.



Text-fig. 6.

The first and second divisions are conspicuous and take place before there has been any great digestion of the reserves. Three drawings of these large dividing nuclei are shown in Fig. 6 *a*, *b*, *c*. Prior to emission of the germ tube further divisions (from one to four) have taken place so that the germinating oospore may have eight large nuclei or very many small ones.

A reversal of the stages passed through in the formation of the oospore within the oogonium has taken place. The oospore now almost fills the oogonial cavity; its protoplasm, though without obvious food reserves, is active, and it contains many relatively small nuclei.

The last stage before emission is the piercing of the thin transparent resistant walls: exospore and oogonial wall. Here again are two independent processes, for it is often observed that the germ tube has forced its way through the oospore wall and has then wound its way about within the oogonial wall unable to penetrate it (Fig. 7 *d*, *e*). It appears as if the oospore wall, which is extensible, is pressed thin at one point until it gives way, but that the oogonial wall which is not extensible is cracked.

The germ tube may be emitted before or after all the oil is absorbed into the protoplasm, and before or after the endospore is entirely digested.

The germ tube, it seems, may be emitted anywhere: presumably at the weakest point. There is no germ pore. Further germ tubes may be emitted at other points but not as a rule if the first is making vigorous growth (Fig. 7 *f*, *g*).

Single germinating oospores isolated and transferred to fresh media give mycelia as before, bearing all the various reproductive organs, and thus demonstrate homothallism.

The precise conditions that ensure germination of the oospore lie within narrow limits. Moreover at any stage during the absorption of the endospore, a secondary dormancy may set in more resistant even than before and more difficult to break. The oospores then may lie for months waiting for the magic touch that originates the emission of the germ tube. Among a collection of oospores, thin-walled, multinucleate, with reserves absorbed into the protoplasm, obviously just primed for germination, only occasional ones are found germinating. The extremely resistant double envelope of exospore and oogonial wall will not give way.

This is a very difficult step and it may be that there is no magic touch

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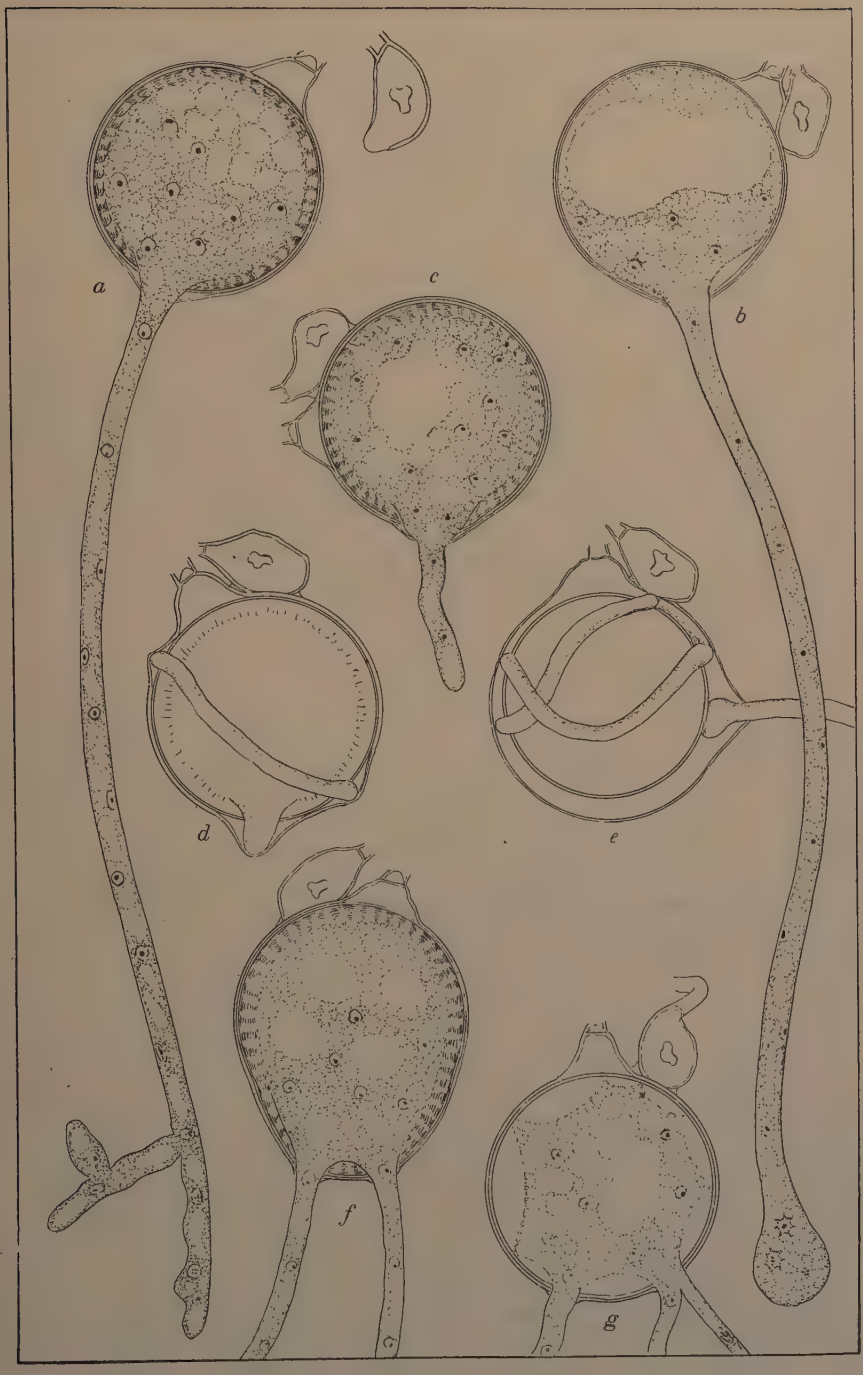
Legend to Text-figure 7.

Fig. 7. The germinating oospore. (*a*) has germinated to give a mycelium direct. (Note the detached antheridium.) (*b*) has germinated to give a sporangium. (*a*)–(*e*) have each produced one germ tube, (*f*) two germ tubes and (*g*) three germ tubes. (*a*), (*c*), (*d*), (*f*) have germinated before the endospore is absorbed, (*b*), (*e*) and (*g*) after complete absorption of the endospore. (*d*) and (*e*) have germ tubes which penetrated with difficulty after winding about between exospore and oogonial wall. (*f*) has been pulled lengthwise by the growth of two germ tubes in one direction and so become ovoid in form. N.B. (1) the extreme resistance and inelasticity of the oogonial wall and the persistence of the antheridial wall. (2) the thin resistant exospore. (3) that the endospore may be digested before or during germination. (4) that the oil globule may be broken up into smaller ones or gradually absorbed before or during germination. (5) the germ tubes may be one or more. (6) the germ tube may give rise to a mycelium direct or to a sporangium. (7) the antheridium very rarely breaks away. (*a*), (*b*), (*c*), (*f*) and (*g*) are composite drawings of median longitudinal sections. × 1000. (*d*) and (*e*) are outline drawings of oospores in surface view as seen through the transparent oogonial wall. × 1000.



Text-fig. 7.

for oospores in the mass: for each oospore makes its own cracks, has formed its own growth substances, produces as a result of its own respiration its own changes in acidity, makes its own peculiar response to conditions outside (e.g. to an alkaline medium produced by bacterial colonies), because each is a slightly differently organized unit. But what better fortune could any parasite have than that its resting spores should not all germinate in one and the same set of conditions?

My grateful thanks are here offered to Mr R. J. Tabor, of the Imperial College of Science, London, who supplied the original culture and advised me that the species was worth a careful study; to Sir Edwin J. Butler and to Mr Ashby, some-time Directors of the Imperial Mycological Institute, Kew, for kind encouragement in the work; to Mr William Horton of Liverpool University, who in the early days of the investigation kindly undertook some of the labour of embedding fixed material and cutting sections; to Dr Margaret Madge of this College, and to Mr Edmund Mason, Mycologist, Imperial Mycological Institute, for their ever-ready help and criticism at all times, and for reading the manuscript; and especially to Miss Grace Waterhouse, of this College, for information, as yet unpublished, from her notes on the microchemistry of the walls, for much useful criticism, and for reading the manuscript.

Summary

An account is given of the life history of *Phytophthora Cactorum* (Leb. & Cohn) Schroet., a paragynous, homothallic species.

The mycelium and reproductive spores in their development and germination are described as under:

The mycelium: its vegetative growth and form and its perennation.

The sporangium, conidium, resting conidium, chlamydospore: their interrelationships, development and germination.

The oogonium and antheridium: fertilization.

The oospore: its dormancy and germination.

REFERENCES

Bary, A. de (1876). Researches into the nature of the potato-fungus *Phytophthora infestans*. *J. Roy. Agric. Soc. England*, S. 2, xii, 239–69. Reprinted in *J. Bot.* (*London*), xiv (N.S. v), 105–54.

Bary, A. de (1881). Zur Kenntniss der Peronosporeen. *Bot. Ztg*, xxxix, 521–625.

Blackwell, E. M. (1935). Germination of resting fungal spores. *Nature*, cxxxv, 546.

Blackwell, E. M. & Waterhouse, G. M. (1931). Spores and spore germination in the Genus *Phytophthora*. *Trans. Brit. myc. Soc.* xv, 294–321.

Blackwell, E. M., Waterhouse, G. M. & Thompson, M. V. (1941). The invalidity of the genus *Pythiomorpha*. *Trans. Brit. myc. Soc.* xxv, 148–65.

Cotner, F. B. (1930). The development of the zoöspores in the Oömycetes at optimum temperatures and the cytology of their active stages. *Amer. J. Bot.* xvii, 511–46.

Couch, J. N. (1941). The structure and action of the cilia in some aquatic Phycomycetes. *Amer. J. Bot.* xxviii, 704–13.

LAFFERTY, H. A. & PETHYBRIDGE, G. H. (1922). On a *Phytophthora* parasitic on apples which has both amphigynous and paragynous antheridia; and on allied species which show the same phenomenon. *Sci. Proc. Roy. Dublin Soc.* XVII, N.S. 4, 29–43.

LEBERT, H. & COHN, FERDINAND (1871). Ueber die Fäule der Cactusstämme. *Beitr. Biol. Pflanz.* I, Heft 1, 51–7.

MURPHY, P. A. (1918). The morphology and cytology of the sexual organs of *Phytophthora erythroseptica* Pethyb. *Ann. Bot.* XXXII, 115–52.

PETHYBRIDGE, G. H. (1913). On the rotting of potato tubers by a new species of *Phytophthora* having a method of sexual reproduction hitherto undescribed. *Sci. Proc. Roy. Dublin Soc.* XIII, N.S. 35, 529–65.

PETHYBRIDGE, G. H. (1914). Further observations on *Phytophthora erythroseptica* Pethyb., and on the disease produced by it in the potato plant. *Sci. Proc. Roy. Dublin Soc.* XIV, N.S. 10, 179–98.

SCHROETER, J. (1886). In *Pilze Kryptogamen-Flora* von Schlesien von Prof. Dr Ferdinand Cohn, III, i, 236 (1885–9).

TUCKER, C. M. (1931). Taxonomy of the genus *Phytophthora* de Bary. *Res. Bull. Miss. Agric. Exp. Sta.* no. 153, 208 pp.

TUCKER, C. M. (1933). The distribution of the genus *Phytophthora*. *Res. Bull. Miss. Agric. Exp. Sta.* no. 184, 80 pp.

WATERHOUSE, G. M. (1931). The production of conidia in the genus *Phytophthora*. *Trans. Brit. myc. Soc.* XV, 311–21.

WORMALD, H. (1919). A *Phytophthora* rot of pears and apples. *Ann. appl. Biol.* VI, 89–100.

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FUNGUS FORAY, ROYAL HOLLOWAY COLLEGE

25 and 26 September 1942

G. C. AINSWORTH

On Friday and Saturday, 25 and 26 September 1942, a foray was held in the Englefield Green district with headquarters, by kind permission of the Principal, at the Royal Holloway College where Miss E. M. Blackwell had generously placed the facilities of the botanical laboratories at the Society's disposal. Among a number of interesting exhibits displayed in the museum were *Phytophthora infestans* (Mont.) de Bary on *Lycium halimifolium* from Dr G. H. Pethybridge, *Cercospora depazeoides* (Desm.) Sacc. on elder from Dr A. Smith, photographs and drawings by Miss Blackwell, and a much admired series of some 200 sheets of water colour drawings by Miss M. E. Notley of the larger fungi of the neighbourhood.

About twenty-five members and friends assembled on the Friday morning and after lunch set out on foot for the Clockcase wood which was worked for about an hour. The party then proceeded to Cooper's Hill, at one time the Royal Indian Engineering College where Marshall Ward was stationed. Here tea was taken and the grounds explored. In the evening, Mr J. Ramsbottom gave a lecture on Edible Fungi to residents of Windsor Great Park, and, at the College, there was an interesting discussion on the mycological aspects of Mr W. C. Moore's Presidential Address, which culminated in a resolution to Council (see p. 91). The next day, a larger party made a whole-day excursion to the Bishop's Gate area of Windsor Forest.

The rain of the previous week had not nullified the effect of the prolonged dry weather and agarics were not plentiful although commoner species were in fair variety. In the Clockcase wood a specimen identified as *Hydnum zonatum* Batsch. ex Fr. attracted some attention and one enthusiastic mycophagist made a large and miscellaneous collection of edible forms. At Cooper's Hill a number of interesting micro-fungi were found including *Cercospora depazeoides* on elder and *Cristulariella depraedans* (Cooke) v. Höhn., on sycamore. The pathologists added records from the College garden and Dr C. T. Ingold found nine species of aquatic Hyphomycetes on decaying leaves of alder and oak from a pond near the Botany Building. On Sunday morning a fine specimen of *Strobilomyces strobilaceus* (Scop. ex Fr.) Berk. was brought in from Farnham. Mycetozoa and Lichenes were each represented by about a dozen species in a final list (filed for reference among the Society's records) of approximately 225 species.

PROCEEDINGS

Joint Meeting of the British Mycological Society and the Association of Applied Biologists, held at the London School of Hygiene and Tropical Medicine, 9 October 1942.

In the morning the Chair was taken by the President of the British Mycological Society, Miss E. M. Blackwell, M.Sc.; in the afternoon by the President of the Association of Applied Biologists, Dr H. Martin.

The programme, which had been arranged by the Plant Pathology Committee, was devoted to a Discussion on Potato Virus Diseases.

[For a detailed account of this meeting see *Ann. appl. Biol.* xxx, 1943.]

Meeting held in the University Department of Botany, Oxford, 14 November 1942.

The President, Miss E. M. Blackwell, M.Sc., in the Chair.

W. R. Day. Butt-rot in conifers and soil conditions.
W. H. Wilkins. The production of bacteriostatic substances by fungi.
Professor H. W. Florey. Moulds and medicine.
S. P. Wiltshire. A few thoughts on the situation in medical mycology.

ANNUAL GENERAL MEETING

12 December 1942

The Annual General Meeting was held in the rooms of the Linnean Society of London at 12 noon on Saturday, 12 December 1942, with the President, Miss E. M. Blackwell, M.Sc., in the Chair.

After the Minutes had been read and confirmed, the President recorded with deep regret the deaths of three members, Mr F. W. Hildyard, Mr J. W. Haig Johnson, and Mr Rupert Smith, and announced that Mrs Catharine Watts had generously presented Mr F. W. Hildyard's set of the *Transactions* to the Society for the Society's use. Council had decided that the set, which was complete, should be bound, placed in the Secretary's charge, and kept up to date and that volumes might be borrowed by members resident in the British Isles.

The President then briefly reviewed the past year and drew attention to the discussions by all sections of the Society of Mr Moore's Presidential Address. As a result of a memorandum from the Plant Pathology Committee, Council had invited the Association of Applied Biologists to set up a joint committee 'to consider means by which the future development of the study and practice of plant pathology in this country can best be furthered' and this invitation had been accepted. In response to a resolution from a meeting held during the September foray, Council had appointed a sub-committee to study the question of systematic mycology in this country and had, on the recommendation of this sub-committee, set up a small Foray Committee to organize the Society's field work.

Mr J. Ramsbottom was, at his own request, not seeking re-election as an editor and on a motion from the Chair a very hearty vote of thanks to Mr Ramsbottom for his twenty-four years service as an editor was passed with acclamation.

The President concluded by expressing the Society's appreciation of the Linnean Society's kindness in again providing facilities for the Society's meetings.

Mr A. A. Pearson next submitted the Treasurer's Statement. He said that the general financial situation was still satisfactory. The Accounts were adopted on the motion of Mr F. G. Gould who expressed the Society's pleasure at Mr Pearson's recovery from his recent illness.

Dr S. P. Wiltshire was proposed from the Chair as Council's nominee for the Presidency for 1943 and he was elected unanimously. In addition to the retiring President and her predecessor in office, Mr W. C. Moore, Dr C. G. C. Chesters was elected as a Vice-President.

The other Officers, *General Secretary*, Mr J. Ramsbottom, *Secretary*, Dr G. C. Ainsworth, *Treasurer*, Mr A. A. Pearson, and *Editors*, Dr B. Barnes and Dr H. Wormald, were re-elected and Mr E. A. Ellis, Dr C. T. Ingold and Dr J. H. Western were elected as members of Council in place of Dr G. Deacon, Dr P. H. Gregory and Mr J. S. Hughes.

The Plant Pathology Committee's nominations, Mr F. C. Bawden, Mr A. Beaumont, and Mr C. J. Hickman to replace Mr S. D. Garrett, Dr P. H. Gregory, and Dr T. H. Harrison, were accepted.

After two new members had been elected, making twenty for the year, the General Secretary briefly outlined Council's tentative proposals for 1943 and the date for the next Annual General Meeting was fixed for 11 December 1943.

The meeting then adjourned until 2 o'clock when the President gave her address 'On germinating the oospores of *Phytophthora Cactorum*' after which Mr Ramsbottom moved a vote of thanks to Miss Blackwell.

G. C. AINSWORTH

RECEIPTS AND PAYMENTS

for the Year ending 30 June 1942

1941		£	s.	d.
1 July	Balance brought forward... ...	564	14	5
1942				
30 June	Subscriptions to date	285	15	10
	Gifts to Printing Fund	4	18	3
	Profit from Sale of:			
	British Basidiomycetæ	3	16	9
	Diseases of British Grasses ...	15	6	5
	Deposit Interest	2	8	1
	War Loan Interest	17	10	0
		£894	9	9

1942		£	s.	d.
30 June	Cambridge University Press, Cost of printing *Diseases of British Grasses*	101	2	11
	Postages, etc.			
	Treasurer	2	16	11
	Secretary	2	14	11
	Sec. Plant Pathology Committee	1	6	6
	Editor	2	1	6
	Sundry Printing	8	2	11
	Fees of Meetings		10	0
	Purchase of *Transactions*	2	3	9
	Balance in bank	773	10	4
		£894	9	9

CAPITAL ACCOUNT—Robinson Bequest, £50 } *invested in*
Cheesman Fund, £150 } 3½% *War Loan*
Printing Fund, £300 }

A. A. PEARSON, Hon. Treasurer

Examined and found correct, F. G. GOULD
3 *August* 1942